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# Compressed Air

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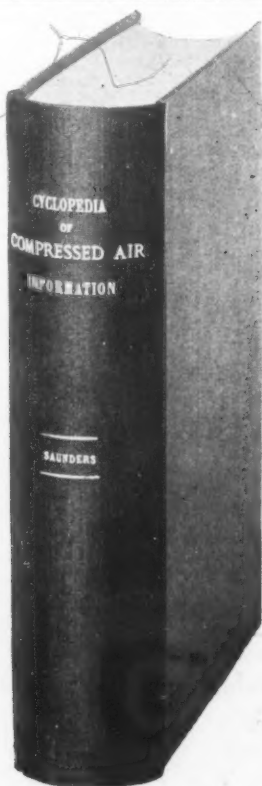
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VOL. VII.

NEW YORK, JULY, 1902.

No. 5.

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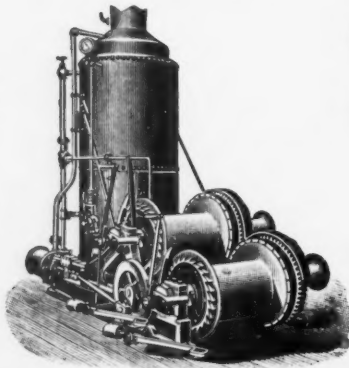
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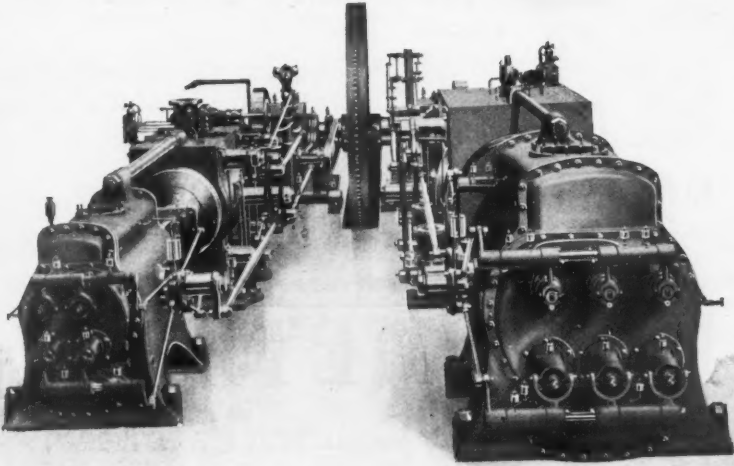
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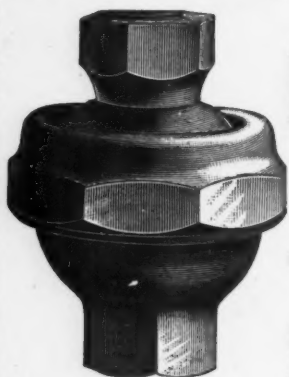
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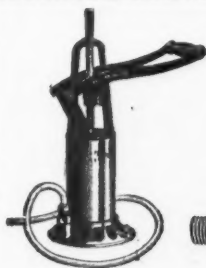


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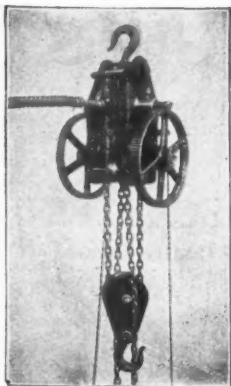
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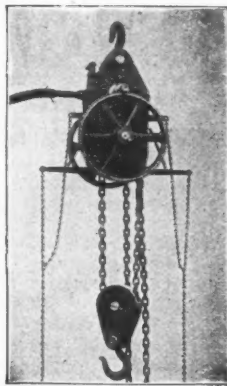
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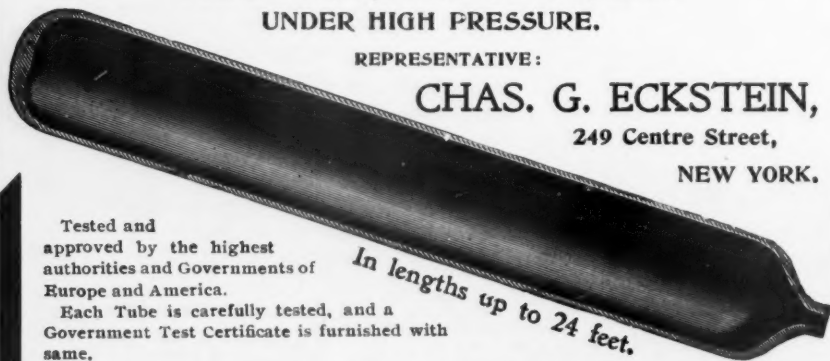
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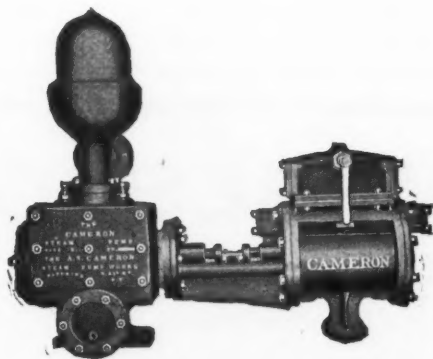
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VOL. VII. JULY, 1902. NO. 5.

Elsewhere in this issue we print an in-  
teresting description of several new de-  
vices to be used in connection with com-  
pressed air for pumping water from deep  
wells.

Within recent years the subject of air  
lifting of water has attracted consider-  
able attention, and many successful in-  
stallations can be pointed out where a  
large quantity of pure water is now ob-  
tained for municipal or private water sup-  
ply where formerly a surface supply of  
inferior or dangerous character was alone  
available.

Where conditions are right the air lift  
seems to have no equal for raising water  
from underground sources. Unfortunately,  
there are sharp limits to the range of eco-  
nomical application of the older or Pohlé  
type of air lift, and the success of this sys-  
tem working under favorable conditions  
has brought to light many propositions  
where conditions as to lift and submer-  
gence are not at all favorable. Frequent  
attempts to devise apparatus suitable for  
such cases have been made. Some of these  
are claimed to attain the desired result of

minimum volume of air and low pressure  
with no working parts and permanency  
and certainty of action. So far as we  
know, however, none of the so-called im-  
provements will stand in the light of im-  
partial investigation.

The methods here shown certainly seem  
reasonable and we should like to hear  
how they work in practice. One feature  
very much in their favor is the lack of  
mystery which usually shrouds "air lift"  
pumps. This feature makes some patent  
air lift pump concerns ridiculous and  
properly arouses suspicion. We recall  
one concern which brings the mysterious  
pump to the well carefully wrapped up  
and places it at night or when no one is  
about. In reality this pump is practically  
the old Pohlé arrangement.

With this issue we reproduce the illus-  
tration which appeared as the frontis-  
piece of the June number of COMPRESSED  
AIR, with an idea of again calling atten-  
tion to the book "Cyclopedia of Com-  
pressed Air Information." The work of  
classifying and arranging the mass of ma-  
terial which will be included is well under  
way and we are looking forward to the  
appearance of the book within a reason-  
able time.

An effort is being made to include such  
material and data as will be of the most  
service as a historical and technical record  
of the advance in the science of air com-  
pression and the practical application of  
air to the arts and industries.

No attempt is being made to change or  
re-write and the book, as already ex-  
plained, will be simply a reprint of the  
best material which appeared in the first  
five volumes of COMPRESSED AIR, arranged  
according to subject under the head-  
ings of "Production," "Transmission" and  
"Use." In this way the information is  
made available for study or reference,  
and will, we think, be in the most valuable  
form. Since our first announcement we  
have received many favorable letters in-  
dicating that the "Cyclopedia of Com-  
pressed Air" will fill a gap in the liter-  
ature on compressed air, and we are en-  
couraged to believe it will meet with an  
even more friendly reception when it ac-  
tually appears.

### **The Harris System of Pumping by Compressed Air, as Applied at the Deloro Mine.**

The raising of water from mine workings is often a serious problem, and always a heavy cost on mining, even under favorable conditions; this subject, therefore, is a matter deserving of serious consideration.

At the Deloro Mines, Hastings county, Ontario, a shaft was being sunk which had an inflow of water amounting from 400,000 to 500,000 gallons per 24 hours. To deal with this amount of water by the then existent plant of "direct-acting steam pumps" was both slow and costly.

The greater part of this water flowed into the mine through and along the foot-wall, at the south end of the ore chute, and from thence to the lower workings, where the shaft was to be sunk.

The writer conceived the idea of impounding most of this water, making a permanent pumping station on the third level, and thus practically leaving the lower workings dry. An old shaft at the south end of the ore chute, being admirably situated to suit this purpose, was selected.

The bottom of this old shaft was 47 feet below the second level and full of water, and 35 feet above the third level, which latter had already been driven under and past this shaft.

The work preparatory to the installation of this pumping system was as follows:

A chamber 30 x 15 x 12 feet was blasted out on the third level immediately under the bottom of the old shaft, and all necessary preparations made for constructing a dam to prevent the water from flowing into the third level. This being done an upraise was made to the bottom of the old shaft, thus unwatering the shaft.

While this work was in progress investigations were made of the several types and varieties of pumping engines. The direct-acting pump was out of the question. Plunger pumps driven by compound-condensing engines seemed the best in this line of pumps, but the situation was such that, should anything happen to the pumps or engine, they would be drowned before repairs could be effected.

The next thing presenting itself as suitable was the "Harris" system of lifting water by direct air pressure.

Not only did this system promise great economy over previous installations, but its construction was such that no machinery was required in the mine, other than two tanks and some pipes connecting them with the machinery on surface; and with this system there could be no drowning, no matter what happened to the surface equipment.

The objections against its adoption were these, viz., its greater first cost compared to other systems, and secondly it was an untried system as applied to a comparatively high lift mining installation. However, against these, its simplicity so appealed to the writer that it was finally adopted.

The two tanks, 4 ft. x 20 ft., were placed in the "sump" or "chamber" on the third level, the pipes connected to surface and the dam built.

The reservoir thus made (that is, the chamber at the bottom of the shaft 30 ft. x 15 ft. x 12 ft., and the shaft itself, being 82 feet below the second level, and 9 ft. x 15 ft. in cross section), altogether gave a storage capacity of 130,000 gallons approximately, thus permitting the engines at surface, if so desired, a period of from 6 to 7 hours' rest, without any fear of the water finding its way to the lower workings.

This arrangement has proved very satisfactory and has been a strong factor in reducing the cost of operations, not only in shaft sinking, but also in stoping; these places now being dry, comparatively speaking.

It had also reduced the cost of raising water from 25 to 30 per cent. on former cost—part of the economy being in fuel, but mainly in labor and repairs.

Formerly it was necessary to have a pump man constantly attending the pumps; now this service is entirely dispensed with. It will be apparent from what has been said, that this system is only applicable as a "stationary pump," but as such it is, in the writer's opinion, very satisfactory.

The "Harris" system of air-lift is composed of two tanks in the mine, which are connected by two air pipes to an automatic switch located in the engine-house at surface, the switch in turn being connected with an air compressor.

The principle of the system is simplicity itself, although not easy of explanation.

A "cross compound" "steam and air"

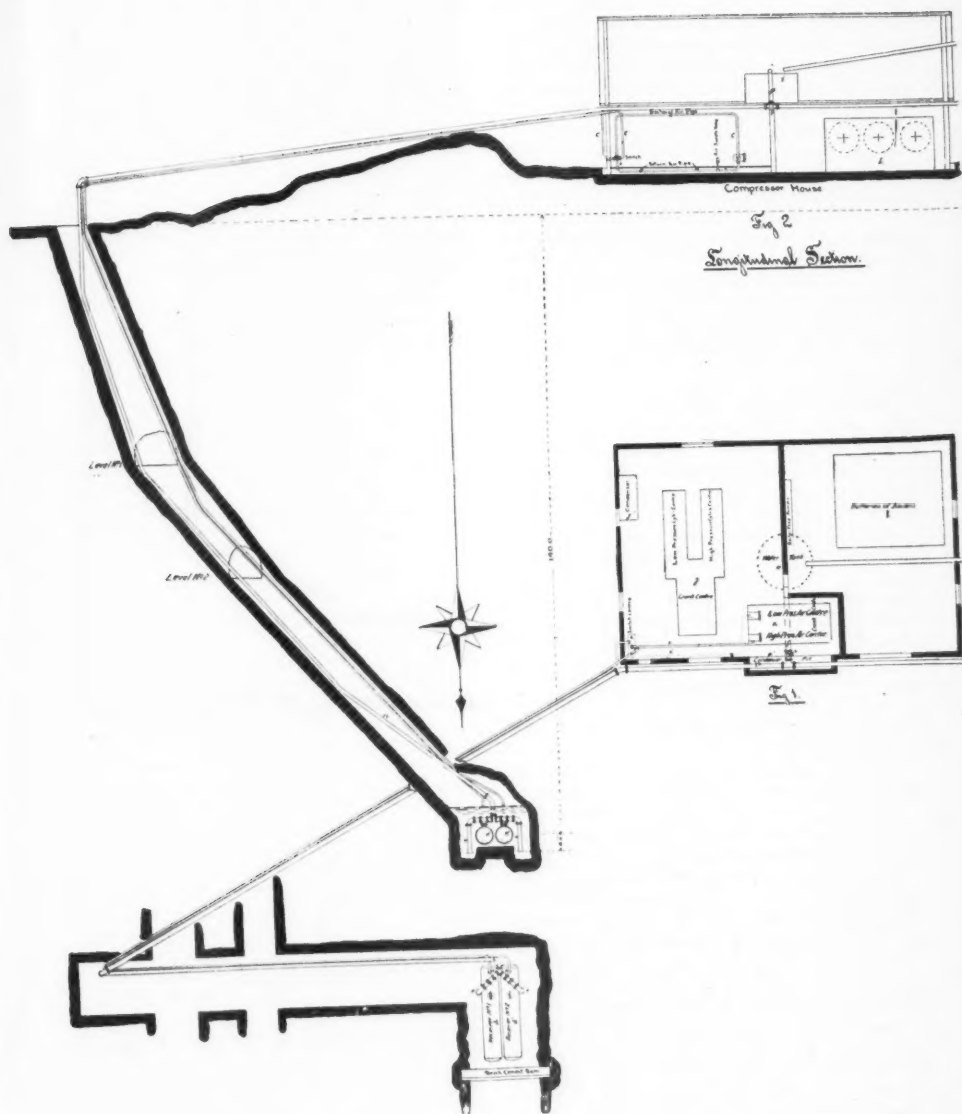


FIG. I. DISPLACEMENT METHOD OF RAISING WATER BY COMPRESSED AIR, DELORO MINE, HASTINGS, ONT.

of the Rand type, class B, compressor is placed at a suitable location at the surface, and two tanks, 4 ft. x 20 ft. each, are placed in the mine—the air compressor and tanks are connected by two air pipes, and between the air compressor and the tanks at a suitable point near the compressor a switch is located.

This switch serves the purposes of changing the inflowing air from one tank to the other at regular intervals; these intervals are termed "cycles."

The duration of the cycle may be varied from  $2\frac{1}{2}$  to 6 minutes, to conform to the amount of the water to be raised; these variations are governed through the amount of air forced into the system.

If there is only a limited amount of water to be raised (and there is no object in maintaining a constant supply), provided that the sump or reservoir is of sufficient capacity, the engine may be stopped for a time and again started by simply turning steam on the compressor, the switch at once resuming its functions, no attention being required at the tanks in the mine.

As regards the air, the system is "closed" or return pipe system, i. e., the same air is used over and over again, returning to the compressor at the end of each cycle for compression, ranging in pressure from that required to do the work, to that which equals the pressure due to the head of water around and above the tanks.

The greater the head above the tanks the greater the economy.

In this feature is the chief economy. The tanks are so connected that they receive air and water alternately—when one receives air and delivers water, the other receives water and delivers air.

It will thus be seen that the air is not brought up to working pressure from the atmospheric pressure, as would be the case in the ordinary air compression.

Attention should be drawn to the fact that the only moving parts in the mine are the inlet and outlet valves at the tanks.

These valves only move once for each cycle, and as near as can be ascertained by listening to them, they open quickly but close gradually, hence the wear is slight. In this case they have never caused any trouble.

In the particular plant under review 96 pounds air pressure is required to force the water through an 8-inch pipe to the

mill tank, a vertical lift of 208 feet. The "lift" is kept running steadily night and day in order to supply the requisite water for mill purposes, also for condensation purposes in the compressor house for the condenser of the air lift, and also another pertaining to a 20-drill compressor.

As before stated, the air is forced into the system at 96 pounds pressure, and after the completion of the cycle it returns through the switch into the low pressure air cylinder at a pressure of 65 pounds, immediately after switching, and gradually decreases in pressure through the cycle to zero, or the pressure of the

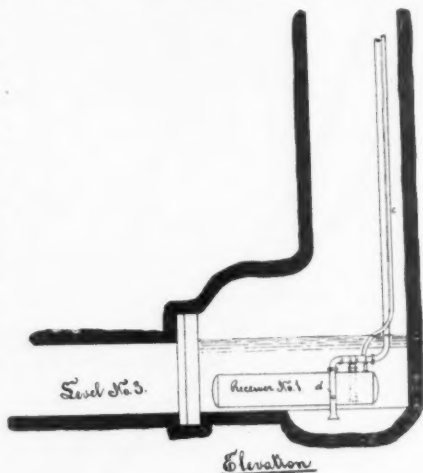


FIG. 2. SECTION OF SUMP SHOWING ARRANGEMENT OF TANKS.

atmosphere; on reaching this point and the compressor still running and having no other source of supply (it should be noted that there is a small loss of air through leakage and the working of the switch, as this latter is exhausted into the atmosphere, this loss is made up by a supply of air through a small check valve on a three-eighths inch pipe, fixed to the low pressure inflow pipe), it follows, therefore, that all the air in the system is extracted, and finally a partial vacuum is created within the tank and pipe line of that side of the system; this vacuum continues to increase until it reaches a point where the atmospheric pressure on the surface of the water overcomes the

weight of the inlet valve on the suction pipe connected to the tank, and the water rushes in, filling the tank. The vacuum will vary with the height of the water; if below the tank, switching will take place at about 11 inches; if above the tank, at 4 to 5 inches or less.

The switch in general appearance resembles a direct acting steam pump, having what corresponds to both steam and water ends. At what would be the steam end, there is a vertical cylinder serving the purpose of the valve; in this works a piston. The space above the piston is directly connected with the air inlet of the compressor, but the space under this piston is open to the atmosphere; it therefore follows that as the low pressure cylinder exhausts the air out of the tank and the pipe connecting it with the switch, creating a vacuum, a vacuum is necessarily thus produced above the little piston; when this point is reached, the atmospheric pressure pushes the piston upwards, and this in turn being suitably connected with a rotary valve on a  $\frac{1}{4}$  inch pipe connected with the high pressure air pipe, opens this valve, admitting the air, which acts upon another piston similar to the steam piston in an ordinary pump. This latter piston is directly connected with a plunger, corresponding to the water-end of a pump, but this latter acts as a valve, opening or closing the passages leading to the pipes connecting compressor and tanks with the switch.

The drawings that accompany this brief description give a general view of the arrangement of the "Harris System of Air Lift" as applied to the raising of water at the Deloro Mine.

Figure 1 gives a plan and elevation of the system as installed, while Figure 2 shows the third level retaining wall and sump in section.

Referring to the drawings, *a* is a cross-compound steam and air Rand drill compressor, type B, steam, 10-16-16, air, 14-8-16; *a* is a condenser; *b* is the switch located in the engine-room; *c c'* are 3 in. air pipes leading from the compressor to switch, and from switch to tanks, in the mine; *d d'* are the tanks, each 4' x 20' with an approximate capacity of 1,800 gallons each; *e e'* are the suction pipes; *f f'* the valves on the delivery pipes *f'* the 8 in. delivery pipe; this, as also the air pipes, *c c'*, are securely clamped between timbers, at intervals up through the shaft, and

from the collar of the shaft are laid together until they reach the compressor building; here the air pipes are connected with the switch, while the water pipe is secured under the eave of the house, running the full length of the building, 75 feet, and from thence up the hill on trestles, until it reaches the mill at the level of the ore floor, a total vertical height of 65 feet, above the collar of the shaft; here the pipe empties into a tank, *g*, 6 feet in diameter, by 8 feet deep; this tank is in turn connected with another tank, *g'*, at the opposite corner of the mill; these are the supply tanks for the mill; *h* is an 8 inch overflow pipe connected through the bottom of the tank, *g*, and leading back to the circulating tank, *i*, in the compressor building.

This was done to obviate any waste of water, which might otherwise occur if the mill at any time needed less water than the regular supply.

On the delivery pipe, *f'*, at *f*, a 6 inch branch is fixed, leading to the circulating tank, *i*; on this 6 inch pipe is a valve, *f'*, for the purpose of regulating the amount of water needed for the compressor condensers.

For about four to six months in the year all the water raised by the air-lift from the mine is needed at the mill, and during this time, the condensers, as also the boilers at the compressor, are supplied by an auxiliary pump located on the river; (*j* is a 20-drill cross-compound steam, single acting air, Rand compressor, furnishing air for all underground work, *j'* the condenser); *l* a battery of three, 100 h. p. each, return tubular boilers.

Fig. 4 shows the position of the tanks in the mine; it will be noticed that these are located at the bottom of a shaft ending on the third level. As already explained, nearly all the water of the mine is confined to this place, the fourth level is almost dry, as is also a winze lately sunk to the fifth level; it is also pointed out that work is being pushed to pass under the bottom of the water shaft, leaving 50 feet of the ore in place.

When this air-lift was put in, it was thought quite probable that the water would break through to the fourth level, it was therefore specified that the lift should be capable of lifting 500,000 U. S. gallons per 24 hours from the fourth level, this would add about 70 feet more to the vertical lift. The makers of the plant

have given a guarantee that the plant will perform the above duty, should it be necessary to move the tanks down.\*

The writer would like to give more detailed data covering the efficiency of the plant, but owing to the fact that the steam used for the lift is drawn from the same boilers that are supplying the larger compressor, and this latter running constantly, there has been no opportunity to make a

test other than a series of "cards" taken at intervals of 15 seconds, throughout the cycles, both from the steam and air cylinders.

These cards are very interesting, showing the variations throughout the whole cycle—there are no two cards alike, but the very fact of this variation makes them of little value—no information of value can be deducted from them.

A table showing these variations is hereto attached.—J. P. KIRKGAARD, Deloro, Ont., in *Canadian Mining Review*.

\*This plant has been in operation continuously for over a year, raising from 300,000 gal., the minimum, to 650,000 gal., the maximum, per 24 hours.

### INDICATOR CARDS, TAKEN JUNE 8TH, 1901.

#### HARRIS AIR-LIFT CROSS-COMPOUND AIR COMPRESSOR ENGINES.

No. Card.	Time in Cycle.	Gauge reading H. P. Steam.	Gauge reading L. P. Steam.	Gauge reading H. P. Air.	Gauge reading L. P. Air.	Revolutions per minute.	End of Cylinder.	Card taken by	Remarks.
1	Start Switch.....	90	25	110	20	124	Both.	Swallow	
2	15 seconds.....	90	28	105	110	120	"	and	
3	30 ".....	90	30	110	105	140	"	Donaldson	
4	45 ".....	90	30	95	95	148	"	"	
5	1 minute.....	89	30	95	80	120	"	"	
6	1 ".....	90	31	93	80	144	"	"	
7	1 1/4 ".....	89	30	93	60	144	"	"	
8	1 1/4 ".....	90	30	92	75	120	"	"	
9	1 1/2 ".....	90	28	91	55	148	"	"	
10	1 1/2 ".....	90	28	92	45	144	"	"	
11	1 1/2 ".....	90	27	90	40	148	"	"	
12	1 3/4 ".....	90	26	92	45	128	"	"	
13	1 3/4 ".....	91	25	91	42	132	"	"	
14	2 ".....	89	25	91	40	124	"	"	
15	2 1/4 ".....	89	22	91	34	148	"	"	
16	2 1/4 ".....	90	23	92	35	124	"	"	
17	2 1/2 ".....	89	23	90	30	148	"	"	
18	2 1/2 ".....	91	23	91	35	136	"	"	
19	2 1/2 ".....	90	22	92	33	140	"	"	
20	2 3/4 ".....	89	22	92	30	140	"	"	
21	3 ".....	90	22	91	32	144	"	"	
22	3 1/4 ".....	91	22	91	30	136	"	"	
23	End of Cycle. ....	90	21	92	30	132	"	"	

## COMPOSITE CARDS.

No. Cards.	Time from.	STEAM.		AIR.		Rev.	End of Cylinder.	Remarks.
		H. P.	L. P.	H. P.	L. P.			
24	0 to 30 sec.	90	20	110	20	140	Crank.	High and low pressure cylinders.
		90	30	90	100	140		
25	1½ min. to 2 min.	90	28	92	50	131		
		90	23	92	35	131		
26	2½ min. to 3 min.	90	22	92	30	127	Head.	<i>Composite Card Explained.</i> — Pencil kept in contact with card during the 30 seconds.
		90	22	92	30	127		
27	0 to ½ min.	90	20	110	20	132		
		90	30	100	100	132		
28	1½ min. to 2 min.	90	27	93	50	143		
		90	23	92	35	143		
29	2½ min. to 3 min.	90	22	92	34	134		
		90	22	92	30	134		

## AIR CYLINDERS.

30	Switch..	90	20	60	20	136	
31	½ min.	90	30	100	105	136	
32	1 “	90	31	90	82	148	
33	1½ “	90	29	93	60	140	
34	2 “	90	25	92	40	152	
35	2½ “	90	22	92	35	144	
36	3 “	90	22	92	32	120	
37	3½ “	90	21	92	30	142	

### Electro-Pneumatic Control of the Moon Island Sewage Reservoir.

The term "electro-pneumatic" is a familiar one to railway signal men, and from what is known of the possibilities of pneumatic operation under electrical control in that field, it is not surprising that useful application should be found for the system in other lines of engineering. At the Moon Island sewage reservoir, in Boston, there is an installation of Westinghouse electro-pneumatic apparatus and machinery which controls the flow of sewage into and out of the reservoir, the appliances in some respects being similar to the controlling part of the electro-pneumatic

of the sewage and gases into dwellings and stores or a premature discharge, which if taking place just after low water and continuing for a time, would cause sewage to be carried to all parts of the harbor amongst the shipping and around the wharves. Even under normal discharge conditions large quantities of sewage covered much of the surface of the upper harbor.

Obviously it was necessary that some system be adopted which would provide a more sanitary condition along the water front of the city, and the solution of the problem seemed to be in the construction of storage reservoirs (at a point in the lower harbor) of sufficient capacity to care for all sewage during such times as the

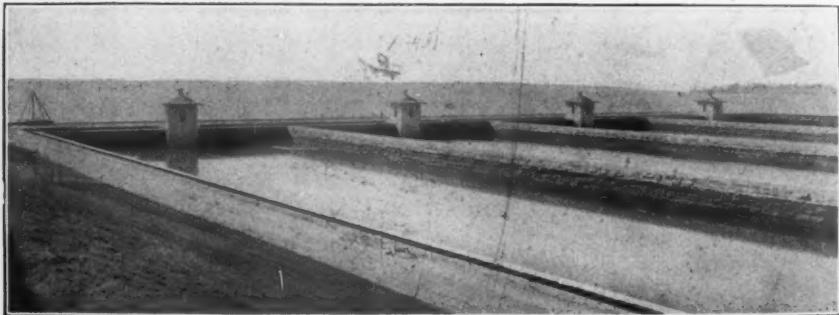


FIG. I.—MOON ISLAND SEWAGE RESERVOIR, BOSTON, MASS.

push-button machine for operating railway switches. Before describing the appliances now in use a resume of the sewage systems of the city may be of interest and also may assist those who are unfamiliar with the subject to understand more fully the functions accomplished and the causes which led to the present installation.

Under the old system, all sewers terminated at tide gates at different points in the harbor, these gates opening and allowing discharge as the pressure in the sewers overcame the resistance of the sea at low tide, and closed again as the tide raised and pressure became greater from the sea side.

During flood, high water and part of the ebb tide, sewage was necessarily stored in the sewers themselves, and this, during or after heavy storms, led to a congested condition which caused either a backing up

tide was not favorable for its immediate passage to sea upon discharge; the rearrangement of the existing sewers in order that their flow might be centralized for passage to the reservoirs; and the erection of new sewers from such a point of centralization.

The location for the reservoir was found at Moon Island, where channels from both Dorchester and Quincy bays offer a strong tidal flow and where conditions affecting both erection of reservoirs and sewer to the main land offered least difficulty in the way of engineering. Means of centralizing the flow of all the main sewers to a point convenient for connection to Moon Island were found in a system of intercepting sewers converging at a point on Dorchester Bay (at what is known as the Cow Pasture) and communication with Moon Island, a distance

of something over two miles, to be effected by sewer, part of which should pass under Dorchester Bay to Squantum and thence over a partially submerged neck of land to the location of the reservoir.

With a system as outlined above, sewage from all parts of the city would flow by gravity to the terminus of the intercepting sewer at the Cow Pasture, but in accomplishing this a level of 14 ft. below low water was obtained. Conditions effecting a prompt and thorough outflow

#### RESERVOIRS.

The reservoir at Moon Island (Fig. 1) is divided into four basins (No. 1 being on the west side) built with bottoms of concrete covered with asphalt and with walls of granite blocks laid in cement, their total capacity being 50,000,000 gallons. At the northeast corner of Basin No. 4 is located the engine house, and from it, extending across the north end of all the basins, is a gallery under which is a chamber, and by way of this chamber com-



FIG. 2—PNEUMATIC CYLINDER FOR LIFTING FLUSH GATE.

from the reservoirs (by gravity) required that they be at a level above low water and to obtain this high level desired, a pumping plant was found necessary, its function being to elevate from a depth of 14 ft. to an altitude sufficient to give head for flow and discharge. The most suitable location for such a plant was at the Cow Pasture.

munication, from the inflow or "high-level" and outflow or "low-level" sewers, is obtained to the basins.

Sewage from the pumping station enters at the west end through the high-level sewer and by means of a series of gates passes into the different basins at time of storage. Under discharge conditions sewage from the pumping station flows direct

through the chamber, and that in the reservoir (by opening the gates) mingles with it, both flows finding exit through two sewers, at a level of one foot above low water, which lead from the east end of the chamber to the sea.

#### GATE OPERATION.

Power generated by a turbine operated by the sewage flow is utilized for opening and closing the gates which control the filling or discharging of the basins. This turbine is placed in a well under the engine house and by opening a gate (manually controlled) the flow of sewage is directed against it, causing it to revolve.

in time would necessitate the shutting off of the basins for cleaning purposes. This difficulty is overcome by flushing. Sewage at a high velocity is introduced at the opposite end of the basins from the chamber, the head thus obtained having sufficient force to carry all sediment the full length of the basins and out by the discharge gates. A small sewer for this purpose branches from the high-level sewer and is carried to the rear of the basins, where "flush gates" are installed to control the flow.

Owing to the length of the basins, the operation of these gates by the turbine-driven shafting is impracticable, and if

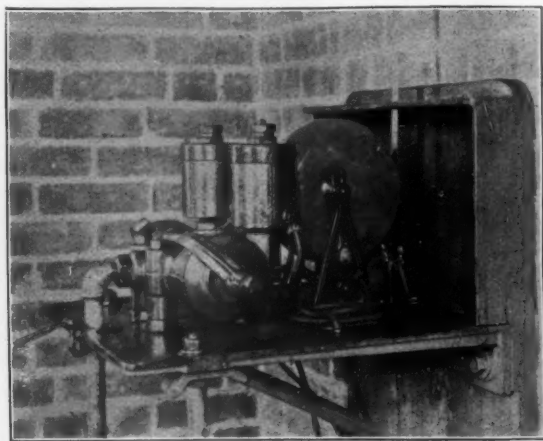


FIG. 3—ELECTRO-PNEUMATIC VALVE MECHANISM.

To the turbine shaft is connected, by means of clutches and bevel gearing, a line of shafting which extends the full length of the gallery and is in turn connected, by gearing, to the different gates. A separate line of shafting runs to a machine shop and furnishes power for the machines used in making repairs. The position of the turbine well is such that either storage or discharge flow is available, and consequently power from this source is constant.

#### FLUSHING.

Both inflow and outflow in the basins, being from one end and of low velocity, allow a deposit of sediment to be left on the bottoms after each discharge and this

operated by manual power would entail an additional force of men whose services would be required only at such times as flushing was actually in progress. Consequently, a system which would make use of the energy supplied by the turbine and be admissible of carrying the power thus generated to a considerable distance for application is found in the use of compressed air controlled by electricity, as arranged in the Westinghouse electro-pneumatic devices, some slight alteration from the standard form in use on railways being necessary to suit the special application here.

The essential features embodied in this installation are: First, the operation of one to four gates located at a distance of from

950 to 1500 ft. from the center of control; second, a power sufficient to operate under varying heads of flow, causing a variance of power required; third, a means of control for each or all gates, by which any one or all may be opened or closed; fourth, an indication of their position, closed or open or in motion.

erected over the flush gates, it being there connected to the operating mechanism. All pipe is carried under ground in hard pine trunking and auxiliary reservoirs are located in manholes at points of connection to the houses and also at the exit of the main air pipe from the engine house. These collect any moisture or sediment

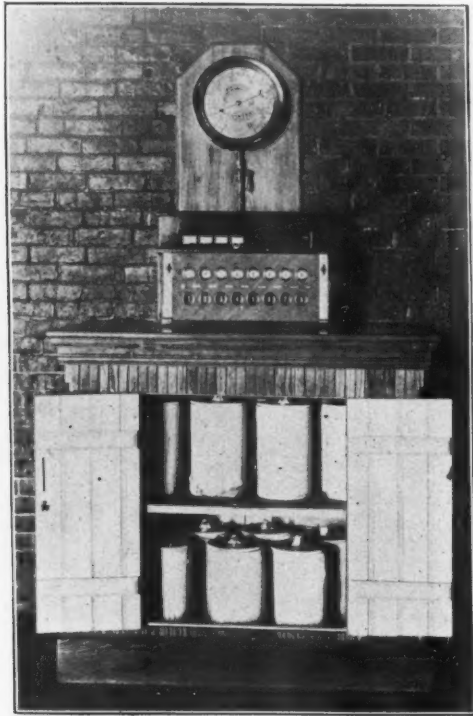


FIG. 4—PUSH-BUTTON CONTROLLING MACHINE.

#### POWER.

Operating power is supplied by an Ingersoll-Sergeant air compressor belt driven from the shafting connected to the turbine. It has a capacity of 69 cu. ft. per minute, at a speed of 120 revolutions. From the receiving tank, located in the engine house with the compressor, a main 1½-in. air pipe is carried along the east side and south end of the basins, and from it ¾-in. pipe branches into the four houses

which may be contained in the air pipe and carried along by the air, and by means of blow-off cocks may be emptied at any time, thus insuring a supply of clean, dry air at the point of appliance.

The flush gates are of iron and raise vertically through grooves in a frame fastened against the granite wall, friction being minimized by the use of composition metal plates on the sliding surfaces; and to insure a minimum leakage are forced

tight against the frame, when down, by wedges attached to the four corners of the gates, the weight of the gate being sufficient to cause the wedges to perform their function. Connected to the gate is the piston rod of a 4 ft. x 10 in. vertical cylinder or ram (Fig. 2) and by the introduction of air at sufficient pressure above or

source of electrical energy required, is used as a support for the push-button machine by which the operation of the gates is controlled and in which the indication is shown. No interlocking of the gates being necessary, the circuits required for their control and the indication of their position, is carried on two No. 9 H. D. C.

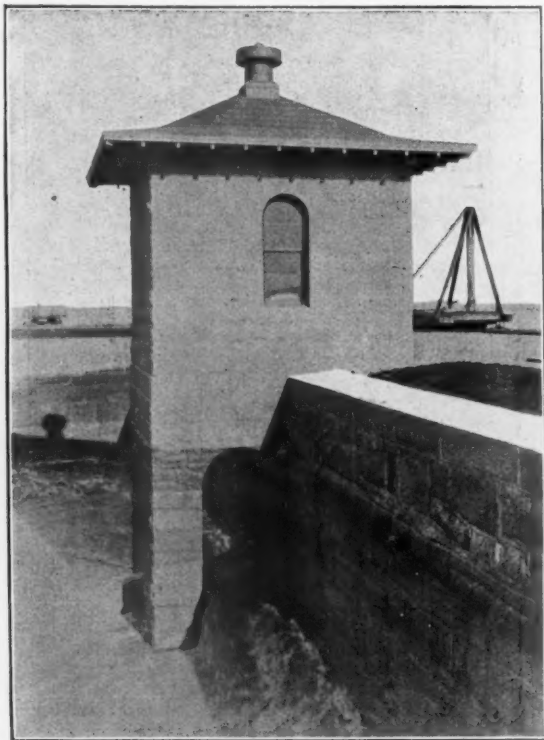


FIG. 5—INFLOW OF SEWAGE TO BASIN.

below the piston head, the piston is forced up or down, thus opening or closing the gate. Pipes of  $\frac{1}{4}$ -in. diameter are tapped into the top and bottom of the ram and are carried to an electro-pneumatic switch cylinder valve mechanism, placed on an iron shelf against the side of the building, as shown in Fig. 3.

#### CONTROL.

In the engine house a cabinet containing 15 cells of Edison-Leland battery, the only

water-proof wires for each gate, the air pipe affording ample means of common return. All wires are run underground in the same trunking with the pipe, but in a separate groove, and as an extra precaution against injury by the action of sewer gas, both are covered with pitch poured over them while hot.

From the machine a 10-wire cable (two wires being spare) is carried to gate house No. 4; from house No. 4 to house No. 3 a

six-wire cable is run; from house No. 3 to house No. 2 a four-wire, and from house No. 2 to house No. 1 a two-wire, the cable in each of the houses being brought to a terminal board. This is done to facilitate the tracing and location of any trouble which might occur, all wires being in practically short stretches.

In the gate houses the wires are connected to the magnets controlling the motion of the slide valve, which by assuming either of two positions, admits air into

corresponding marker shows "red," but upon the completion of the stroke and a consequent ceasing of the current, the marker is released and assumes a new position by gravity where it shows "white."

The controlling buttons in the machine are in pairs, one above the other, as in railway switch operation, and as the upper one is pushed in by the one movement setting the indication arm and making contact which forms the circuit for raising

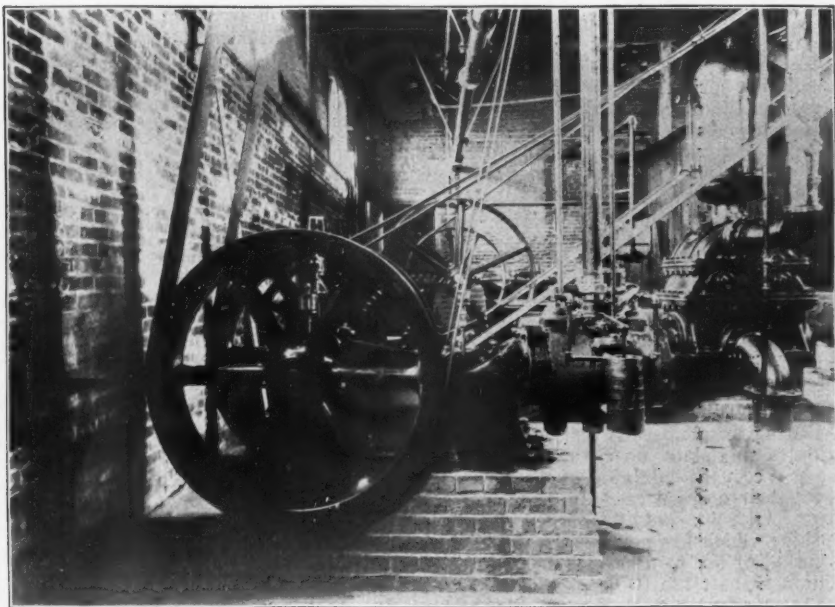


FIG. 6—AIR COMPRESSOR PLANT, MOON ISLAND SEWAGE RESERVOIR.

the pipes to the ram for an upward or downward throw, and by the use of a mechanical arrangement of gears, connected by wire run over pulleys to a light rod which projects through the top of the ram, and being a continuation of the piston travels with it, a new circuit is formed, remaining constant while the gate is in operation and ceasing when the gate reaches either extreme position, up or down. By this latter circuit indication is made in the machine in the engine house, where, during the movement of a gate a

the gate, the lower one is forced out and in: this way the position of the buttons indicate the position of the gate.

The two pipes from the slide-valve to the ram are used alternately as a passage for air applied in the ram or exhausted from it, the exhaust reaching the open air through a small chamber which is part of the valve. On the up-stroke, for opening the gate, air is admitted to the bottom of the ram, and as the piston is forced upward the air above is exhausted through the pipe connecting the top of the ram

with the valve mechanism. On the down-stroke, for closing the gate, the operation is reversed, the top pipe acting as supply and the bottom as exhaust.

The gates weigh 1,500 lbs. and this, when the weight of the piston, the friction in the ram and on the sliding surfaces is added, will be equal to about 2,000 lbs. to be lifted. With no head in the sewer the gates rise at 15 lbs. pressure, and with extreme head at 35 lbs.

On the down stroke, the weight of the gates, etc., would have a tendency to cause a rapid fall if the pressure supporting it was at once discontinued. To obviate this difficulty a swing check valve having a small hole drilled in the seat, is so inserted in the pipe from the bottom of the ram that pressure to the ram causes a full opening, but exhaust causes it to close, the drilled hole allowing but a small escape-ment of air, which, by its slow passage, forms a cushion in the ram and offers sufficient resistance to prevent any sudden fall. Shortly before the time of flushing, the compressor is thrown into service and in about 15 minutes enough air (a gauge pressure of 35 to 40 lbs.) is stored in the receiving tank and pipe line for the operation of all the gates. The compressor may then be shut down until air is again wanted for another operation.

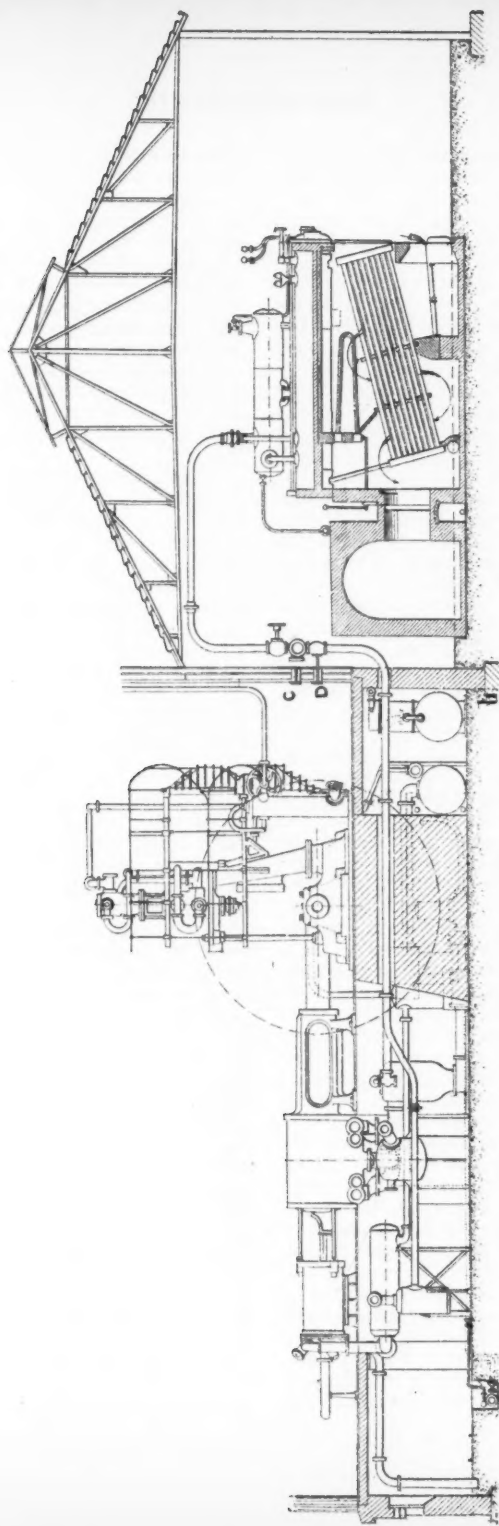
During the almost ten years of the operation of this plant, no changes have been made except the enlarging of the basins to twice their original capacity, this enlargement making necessary the system of flushing which has now been installed for a period of six months. At the pumping station a shaft 140 ft. deep connects with the sewer under Dorchester Bay, this sewer having a diameter of  $7\frac{1}{2}$  ft., being constructed through solid rock. The sewer from Squantum is  $11 \times 12$  ft. inside, and the outflow sewers from the chamber are the same size, but two in number. Storage of the basins takes place for 20 hours each day and 4 hours is allowed for discharge, this being ample time, for the sewage passes out at the rate of 1,000,000 gallons per minute, and the basins may be emptied in about 50 minutes. During discharge, sewage is noticeable for about two miles down the harbor, but in a short time after closing down it is so thoroughly mixed with the salt water that it is entirely lost to observation.—*Railway and Engineering Review*.

### The Billancourt Compressed Air Plant, Paris.

The General Omnibus Company of Paris, France, has built at Billancourt, a suburb to the southwest of the city, a plant of about 7,000 horse-power capacity for the purpose of compressing air to 1,140 pounds per square inch and distributing it to different charging stations along the routes of its compressed air cars. The works are situated on the right bank of the Seine about 5,000 feet below the fortifications of Paris, and form a group of buildings, the largest containing the steam engines and compressors, a smaller one the steam boilers, and a number of detached buildings, one of which is a storage or accumulator building for compressed air. About a year ago 148 cars were in use, with 100 to 120 in operation simultaneously.

The boiler house is 53.5 feet wide and 249 feet long. There are 16 boilers of the Babcock & Wilcox type, set in eight batteries of two each. Each boiler has 2,260 square feet of heating surface, and, besides two steam drums, has a reservoir above the drums forming a steam collector and separator. This is about 31.5 inches in diameter and 14.75 feet in length. Four economizers, each with a heating surface of 2,690 square feet, are placed in the passage of the gases of combustion, and in running service furnish water to the boilers at about 150 degrees Fahrenheit. The smoke passage is located immediately back of the boilers in a masonry tunnel extending the whole length of the boiler room and communicating at each end with a chimney. One chimney is of brick, 197 feet high and 8.2 feet in inside diameter at the top; the other is of sheet metal, 105 feet high, formed into an inverted truncated cone for operation with mechanical draft. The two chimneys may be rendered independent by means of dampers behind each pair of boilers so that the 16 boilers can be operated in two distinct batteries. The cross-section of the smoke passage is about 67.2 square feet. The normal boiler performance is 2.66 pounds of steam per square foot of heating surface, but it is stated that 13,200 pounds of steam are easily obtained per hour from each pair of boilers.

The steam is taken from the steam collector of each boiler in a pipe 5.9 inches in diameter, curved upward from it and then



SECTIONAL ELEVATION OF THE BILLANCOURT COMPRESSED AIR POWER STATION, PARIS, FRANCE.

downward into the top of a steam header placed back of the boilers along the wall separating the boiler from the engine room. The supply pipes to the various steam engines in the compressor room are taken from the bottom of the steam header and carried overhead in a basement story to a separator from which the pipe passes upward to the engine cylinder. The valves dividing the steam header into various sections and the valves in the supply pipes to the steam engines have long stems and the valve wheels come within the engine room at man's height above the floor so as to be readily controlled. The engine room contains seven three-stage compressors with triple-expansion condensing steam ends, and four simple condensing engines, the latter driving jack shafts and in this way various electric generators. This room is served from a 15-ton traveling crane bridging the entire width. The piping, condensers, etc., are located in the basement. The engine room is 351 feet long, 69 feet wide and 42.7 feet high in the clear above the floor; the rails of the traveling crane are about 27.4 feet above the floor.

The compressor engines are of 740 horse-power capacity at 52 revolutions per minute and of about 985 horse-power at a speed of 70 revolutions per minute. The steam end, which was constructed by Messrs. Dujardin & Company, of Lille, consists of a high and medium pressure steam cylinder on one side of the engine and a low-pressure cylinder in tandem with the low-pressure of first-stage compression cylinder on the other side; the air end, which was constructed by Messrs. Brissonneau & A. Lotz, of Nantes, consists of a low-pressure cylinder in tandem with the low-pressure steam cylinder, as stated, and of medium and high-pressure air cylinders arranged vertically side by side and driven by cranks from the main shaft. Each compressor has two fly-wheels, one on each side of the upright portion of the machine; they are 21.3 feet in diameter and weigh 33,000 pounds each. Steam cylinders are 51.2, 31.1 and 20.2 inches in diameter, and the common stroke is 55.1 inches. The air is furnished at a pressure of 1,140 pounds per square inch, but this, it is said, can be raised to 1,420 pounds. The compression is carried to about 57 pounds in the first stage, to 355 pounds in the second and to the figures given in the third. There is one cylinder

for the first stage, and two each for the second and third; and all are single-acting. The diameter of the low-pressure cylinder is 39.3 inches, and it has the common stroke of the engine, 55.1 inches; the diameters of the medium and high-pressure cylinders are 22.5 and 10 inches, respectively, with a stroke of 22.5 inches. It is said that the arrangement of a single-acting air cylinder in tandem with the steam cylinder, as described, has proved defective, in the sense that the system is thus out of equilibrium, and it is proposed to replace the cylinder with one double-acting.

A peculiarity about the first stage of the compression is that the air is cooled by spraying water into it as it leaves the cylinder. The water is delivered by a pump driven from an eccentric on the main shaft of the compressor unit, and its supply is regulated by a valve to about 0.24 gallon per pound of air compressed. From the low-pressure cylinder the air is taken to an intermediate reservoir, which acts as a regulator, and from this is a smaller pipe, to give the air a sufficiently high velocity, into a second reservoir; in this it crosses a small column of water to free itself of foreign bodies which are liable to become entrained during its compression. The high and medium-pressure cylinders are vertical, as stated, and driven by cranks 180 degrees apart. The cranks of the steam engines are also set 180 degrees apart, but 15 degrees in advance of the compressor cranks to maintain at every instant as constant a relation as possible between the engine effort and the work of resistance.

After leaving the high-pressure cylinders of the compressors, the air is passed successively through two cylindrical reservoirs, or dryers, each with a capacity of about 120 gallons. The compressed air is distributed through three sets of mains, two leading to the different charging points, and the third to the accumulator house. The mains are of welded steel pipes, 3.04 and 2.95 inches in diameter and in lengths of 64 feet. The accumulator house contains 280 reservoirs of 132 gallons capacity, with a total capacity of about 5,000 cubic feet. These reservoirs are divided into seven batteries, each battery consisting of four groups of ten reservoirs. They are built of steel plate, 1.65 inches thick, and are 10.5 feet high. The apparatus was tested to 1,890 pounds per

square inch, is stamped for 1,420 pounds, and each group of 10 reservoirs carries a safety valve regulated for 1,280 pounds.

Tests show that 8.05 pounds of air at 1,138 pounds per square inch were obtained per indicated horse-power, and 5.94 pounds per pound of coal. One compressor produces about 7,050 pounds of air per hour. The cost of compressing the air when the plant was first operated was \$3.85 per ton of 2,000 pounds, but it has been reduced to \$2.45.—*The Engineering Record*.

### Notes on Indicator Cards from Air Cylinders.

The principal uses of an indicator on the air cylinder of an air compressor are (1) to determine the amount of vacuum that is in the cylinder during the time the air is passing in; (2) to determine the pressure of the air in the cylinder during the time the air is being discharged in the pipe line; (3) to determine the amount of clearance that there is in the cylinder; (4) to determine the H. P. developed in the cylinder.

In applying the indicator the connection from it to the cylinder should be as short as possible, and to obtain the most accurate results an indicator cock and indicator should be directly connected to each end of the cylinder and cards taken from each end. It is, however, customary to run a pipe from one end to the other and connect the indicator in the centre with the necessary three-way valve or two cocks. For ordinary purposes this is sufficiently close.

In the case of a small compressor, say 6" x 6", the volume of air included in the usual 1/2" pipe from one end of the cylinder to the three-way cock in the centre would amount to about 2.5 cu. ins., or 1.5 per cent. of the cylinder volume. When compressing to 75 pounds pressure this would cause a loss in volumetric efficiency of 9 per cent., which loss would not occur when the indicator was not in use. In larger machines this loss chargeable to the indicator disappears, amounting in a 16" x 18" cylinder to 0.14 per cent. of cylinder volume, or a loss of 0.9 of one per cent. in volumetric efficiency when compressing to 75 pounds.

For the purpose of following the va-

rious parts of the card in Fig. 1 we will letter the several lines thus:

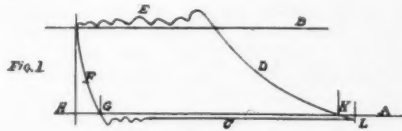


FIG. 1.

A is the atmospheric line and is the line drawn on the card by the indicator pencil when the indicator is cut off from the cylinder and there is no pressure under the indicator piston. This line should be very carefully drawn and care should be taken that the cocks are not leaking so as to allow pressure to accumulate beneath the indicator piston. A slight error in drawing this line will lead to very incorrect results when figuring the volumetric efficiency of the compressor.

B is the line indicating the pressure in the pipe line or receiver. This is not drawn by the indicator, but may be drawn in by hand on the card after the card is removed from the indicator. It should be parallel to line A and a distance above it equal to the observed gauge pressure in the pipe line or receiver.

C is the intake or suction line and is the line drawn when the air is passing into that end of the cylinder.

D is the compression line. This starts at the end of the suction line and rises as the piston compresses the air until it reaches a pressure sufficiently high to open the discharge valves. The air then begins to pass out of the cylinder and the pressure ceases to rise. E, the discharge line, represents this part of the card.

F is the expansion line and represents the drop from the discharge pressure to the suction as the piston at the end of the stroke ceases to discharge and once more begins to take in a new supply.

The following are the characteristics of the various lines:

Beginning with line C, there must always be a slight vacuum during the suction period, as this is necessary to cause the air to flow into the cylinder. The amount of vacuum depends on the size of the inlet ports, and the character of inlet valve; the smaller the ports and passages in proportion to the piston displacement the greater the vacuum, as the

air has to travel so much faster while passing through same.

When a compressor is fitted with Poppet inlet valves having springs to close them there must be a vacuum in the cylinder sufficient to overcome the springs and suck the valves open. A wavy appearance in the suction line is caused by the valves fluttering on their seats. No sooner does the vacuum pull them open than the springs pull them shut only for them to be sucked open again. This is the usual action of this kind of valve.

A heavy wave at the beginning of line C is caused largely by the inertia of the indicator parts. The drop from line E to line C is so sudden that the pencil goes past the point it should stop at and then it vibrates a few times before settling down.

The vacuum shown during the suction stroke may vary from nothing to two pounds. With a mechanical or other positively moved inlet valve compressor under the maximum speed it should not exceed one and a half pounds at most. A compressor having spring closed inlet valves might exceed this by one-half pound.

At the end of line C the compression line D commences. This should be a smooth, even curve gradually rising until it reaches the discharge line E. It will cross the line B, as it is necessary for the pressure in the air cylinder to slightly exceed the pressure in the receiver before the discharge valves will open. There is usually a high crest at the end of line D, this being caused by the pressure in the cylinder rising so rapidly due to the high speed of the piston at this point in the stroke that the inertia of the discharge valve cannot be overcome quickly enough to prevent this excess pressure building up. The line E will have a wavy appearance for the same reason as explained in the case of Poppet inlet valves. These waves are usually magnified by the indicator.

There is another cause for the fluctuations and waves that appear in the discharge line and that is the surge of the air in the pipe line between the compressor and receiver. At the moment that the air in the cylinder reaches discharge pressure the air in the pipe line is not in motion and as the piston forces the air out of the cylinder an excessive pressure

is built up, before the column of air in the pipe can be started, this in turn being followed by a drop sometimes below receiver pressure, as the air under the influence of the accumulated pressure acquires a momentum which carries it away faster than it is discharged from the cylinder.

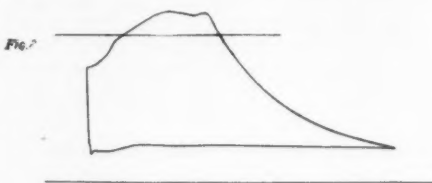


Fig. 2.

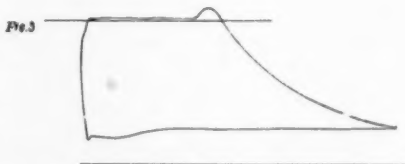


Fig. 3.

The frequency of or time between these surges appears to be constant for any given pipe line, and with different speeds of compression widely different discharge lines will be found. The two cards in Fig. 2 and 3 were taken from a compressor having the discharge valves opened and shut positively and the only difference in the conditions of the two cards were the speeds, being in Fig. 2, 64 R. P. M., and in Fig. 3, 96 R. P. M. In a machine running faster, say 120 R. P. M. or over, the surge would probably not be apparent, but it is evident that with a large compressor running slowly it is a factor to be considered.

In any card, however, there is apt to be a high crest at the end of the compression line even though the after surge is not evident.

In measuring the area of a card an average line should be taken midway between the high and low points. The line F should fall quickly down to line C. It represents the drop in pressure as the piston moves away from the cylinder head and the air in the clearance space

expands from discharge pressure to suction pressure. This line should be smooth and even, but it will sometimes at high speeds have a broken or uneven appearance. This is due in part to the indicator and sometimes to the discharge valves not closing quick enough.

The volumetric efficiency of a compressor is the proportion of the amount of air actually delivered into the pipe line to the theoretical piston displacement of the compressor. To measure this from the card we proceed as follows, the total length H L of the card in Fig. 1 representing the stroke of the compressor: The point G, where the line F crosses line A, indicates the position of the piston when the air, in the clearance space had expanded down to atmospheric pressure. This indicates that an amount of air at atmospheric pressure equal to G H was left in the cylinder at the end of the stroke and not discharged, it being bottled up in the clearance spaces. When the piston reaches the other end it returns to point K before the pressure in the cylinder reaches atmospheric pressure. We have, therefore, in the cylinder only the volume K H of air at atmospheric pressure to be compressed, and as the amount K H remains in the cylinder we only have the amount K G as the net amount delivered. As H L represents the full stroke of the compressor the proportion of K G to H L represents the volumetric efficiency of the compressor.

Should a discharge valve not be tight, the leaking back would be indicated on the card by line C rising and perhaps passing over line A. This would indicate that there was a greater pressure in the cylinder than outside and that consequently the cylinder must be getting air from somewhere under pressure. A more rapid rise of line D on one card than the other would also indicate a leaky discharge valve in one end or a leaky inlet valve in the other end, provided the point L on each end of the card was the same distance below line A.

When both ends of the cylinder are working properly the intersection of the two lines D should be exactly in the middle of the card. Should this intersection be much out of centre one end is not working properly.

The compression line should lie between the isothermal and adiabatic curves and for the convenience of any one who

may wish to draw these curves on a card the following table of pressures is given:

TABLE OF PRESSURES IN AIR COMPRESSOR CYLINDERS.

Per cent. of Stroke.	ADIABATIC.		ISOTHERMAL.	
	Initial Pressure 14.7 lbs.	Multiplier for any Initial Pres.	Initial Pressure 14.7 lbs.	Multiplier for any Initial Pres.
	Col. 1	Col. 2	Col. 3	Col. 4
10	17.05	1.160	16.33	1.111
20	20.12	1.368	18.38	1.250
30	24.29	1.652	21.00	1.428
40	30.18	2.053	24.50	1.667
50	39.01	2.652	29.40	2.000
55	45.26	3.072	32.67	2.222
60	53.41	3.633	36.75	2.500
65	64.46	4.385	42.00	2.857
70	80.08	5.447	49.00	3.333
75	103.5	7.042	58.80	4.000
80	141.7	9.640	73.50	5.000
85	212.5	14.460	98.00	6.667
90	376.1	25.57	147.0	10.00
95	998.1	67.90	294.0	20.00

To draw either curve divide the card into ten parts and draw vertical lines numbered beginning from point L. Then if the point L is on line A, or in other words, if at the beginning of the stroke the cylinder is full of air at atmospheric pressure the points on the several ordinates may be laid off directly from columns 1 and 3 of the table. If the compression line does not begin on the atmospheric line as when there is a vacuum or in the case of the high pressure cylinder of a compound compressor the absolute pressure at point L must be multiplied by the multipliers in column 2 and 4 of the table. This should be done if the compressor is at an altitude which would cause an intake pressure of less than 14.7 pounds per square inch. The curve may then be drawn through the points

In using the above table it must be

borne in mind that the pressures given are absolute pressures and all measuring should be done from the line of perfect vacuum. In fact the safest way to do any figuring with compressed air is to reduce all pressure to absolute in the first place and after the results are obtained subtract the atmospheric pressure for the given elevation in order to obtain gauge pressures.

WARD RAYMOND.

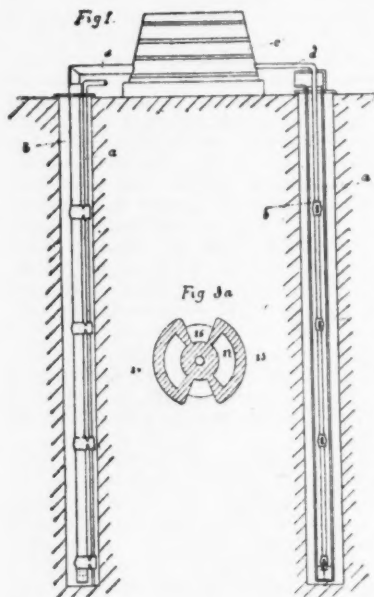
### Raising Liquids from Shafts, Boreholes, Etc., by Means of Compressed Air.

Under ordinary circumstances the pressure of air requisite for raising a column of water is equal to the height of the column in metres divided by 10.33, *i. e.*, if the column of water is to be raised 300 metres high, the pressure of air will have to be 29 atmos., which would entail the erection of a powerful compressing plant, and would, moreover, overtax the strength of the pipes met with in commerce. The necessity for such a course, however, is obviated by the author's new process, enabling liquids to be raised from any depth by compressed air, the pressure of which does not exceed 5 atmos. This object is accomplished by introducing the compressed air into the column of liquid at various levels or points of the upcast pipe instead of at the bottom, so that each jet of air has merely to lift such part of the column as lies between it and the jet next above. Thus, in the case of a column 300 metres high, if 10 compressed air jets be employed, the pressure of 29 atmos. is divided by 10, so that each jet will only need to have a pressure of 2.9 atmos., and therefore no costly compression plant will be required.

Several modifications in the manner of performing this method are illustrated in the accompanying drawings. Fig. 1, for instance, shows on the right a form of plant in which the upcast is enclosed in the air pipe, while on the left of the Fig. the two are arranged side by side. Fig. 2 represents a longitudinal section of a modification of the jets in the case of the external air pipe, and Fig. 3 is the corresponding application to the internally situated air pipe. Fig. 3A is a section along AA of Fig. 3; Fig. 4 is a longitudinal section through the bottom of the apparatus referred to in Fig. 2; and Fig. 5 is the corresponding portion of that re-

lating to Fig. 3. Fig. 6 is a device for regulating the admission of compressed air to the jets.

In Fig. 1, left side, *a* is the air pipe and *b* the wider upcast pipe for the liquid. At certain intervals in the height of these pipes jets are provided for the admission of air to the upcast. These jets consist of short lengths of pipe, *l* (Fig. 2), with screw connections top and bottom for attaching them to the upcast pipe, *b*. In the centre of the short pipe is a small button, 2, which is pierced by a small bore, 3, bent at right angles, for the passage



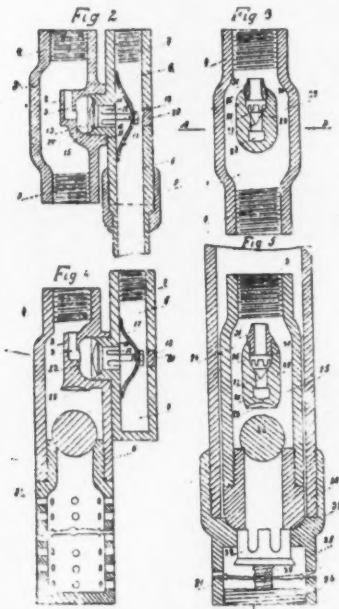
of air. A second short length of pipe, 6, fitted with a female screw at the top and a male screw at the bottom, forms part of the air pipe, and is provided with a lateral adjutage, 10, screwing into a corresponding recess, 11, of the pipe, 1; and thus connecting the lengths 1 and 6 firmly together. The adjutage, 10, is fitted with a central bore, 12, through which the compressed air passes from the air pipe into a hollow space, 13, and thence, *via* 3, into pipe *i*. The central bore, 12, is provided with a valve, 14, which is kept in position on its seat by the pressure of a spring, 15, the tension of

this latter being regulated by a nut, 18, accessible through an opening (in pipe 6) which is closed by a screw-plug, 20.

The apparatus for the bottom of the air and upcast pipes is somewhat different from the foregoing. At the bottom of the short length of pipe 1 is screwed a suction head, the upper end of which is so constructed as to form the seat of a suction valve. The stroke of this ball valve is limited by the button, 2, which is hollowed out at 23 to receive the ball at the end of its upstroke. The bottom length, 6, of the air pipe is closed at its lower end.

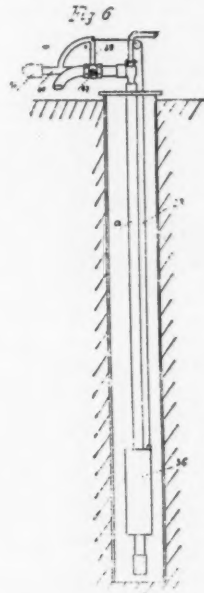
to be raised, the compressed air is turned on, and directly the air-pressure exceeds that of the liquid, the valves, 14, are forced open, and the air drives the liquid up the pipe. The fractions of the column raised by each jet do not exert any pressure on such portions of the column as are below them; consequently the incoming air is in equilibrium, as regards pressure, with the underlying portions of the column, and raises the supernatant portions, so that all the jets continuously aspirate the liquid, and force it up into the reservoir, *c*.

In order to secure the accurate working of the system it is advisable that the in-



As the pipe must be quite full of liquid before the different jets can act simultaneously, it is necessary to provide a raised reservoir, *c* (Fig. 1), close to the borehole. This reservoir is filled with liquid, and is connected with the upcast pipe by means of a pipe, *d*, so that the upcast is always kept full.

The valve, 22, prevents the liquid running out of the upcast pipe, while the valves, 14, keep it from flowing back into the compressed air pipe. As soon as the upcast is full of the water or other liquid



tervals between the air jets should not be equal throughout, but arranged on an increasing scale. Thus in a 300 metre hole, one jet should be placed at the bottom, a second at a depth of 260 metres, the third 219 metres, the fourth at 177 metres, the fifth at 134 metres, the sixth at 90 metres, and the last one at 45 metres from the surface, the intervals thus increasing one metre each time from below upwards. This difference corresponds to a pressure of about one-tenth atmosphere, which compensates for the loss of pressure by friction in the air pipe.

In the right half of Fig. 1 is a modification with the upcast pipe, situated within the air pipe. Apart from the alterations necessitated by the changed posi-

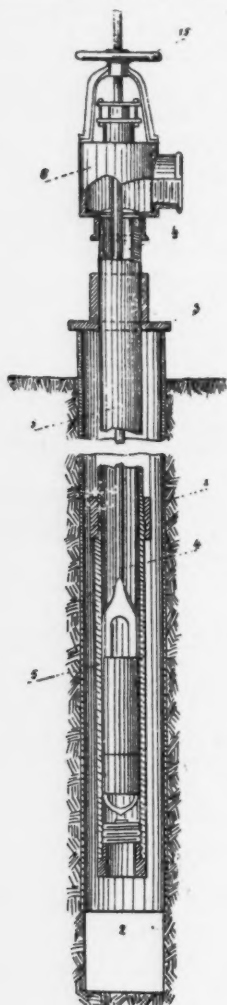


FIG. 7.

tions of the jets, the principle of working remains the same. The jets consist of a cylinder, Fig. 3, provided with two channels, 24, 25, communicating with the screw connections, 4, 5, by which the

short length of pipe is attached to the upcast. The solid block, 26, separating the two channels, 24, 25, is pierced by a narrow central bore, 27, communicating with a lateral orifice, 28. The bore, 27, is kept closed by the weight of a triple-winged conical valve, 29, which moves in a chamber, 30, on the other side. A nozzle, 31, pierced by a bore equal in diameter to that of 27, is screwed into the chamber, 30.

The jet for the bottom of the pipes is arranged in a similar manner, except that the lower end is closed by a sleeve, 36, which is fitted with a ball valve, 22, the upstroke of the ball being limited by the hollow, 23, underneath the block, 26. The air pipe is closed by a suction head, 21, the valve of which, 32, is pressed upwards on to its seat by a spring, 33, which is supported by a plug, 34, thus preventing any influx of water into the air pipe so long as the valve is not forced downward from its seat. In this modification the air pipe is first lowered into the borehole, and then the upcast is put into position. The latter forces open the bottom valve, and rests on a ledge, 35, in the suction head, thus cutting off all connection between the valve, 32, and the air pipe, while opening communication between itself and the valve, and thus admitting liquid from the borehole. On now turning on the compressed air, the latter passes through the lateral orifices, 28, Fig. 3, into the upcast pipe, lifts the valve, 29, escapes through the chamber, 30, and nozzle, 31, and forces up the column of water between this jet and the next one above.

In boreholes the compressed air pipe can be dispensed with if the mouth of the borehole be hermetically closed, and the air blown into the hole itself.

Where, as in the case of some oil wells, the inflow of liquid is insufficient for the air blast to be kept continuously at work, the pressure of the compressed air is in the pipe, *a*, regulated by means of a float, 36 (Fig. 6), which works outside the air pipe and is connected by a chain, etc., 38, and lever, 39, with the compressed air tap, 37, the other arm, 40, of the said lever being provided with a counterpoise, 41. This float follows the rise and fall of liquid in the hole and automatically adjusts the air pressure accordingly, entirely closing the air tap (and reopening same) when necessary.

Another method of raising liquids is illustrated in Figs. 7 to 11, the fundamental idea of which is to produce the same effect as that exercised by the pressure of natural gas on petroleum in spouting wells. The apparatus consists of two

sectional view of the lower part, and Figs. 10 and 11 are cross-sections along XX and YY of Figs. 8 and 9.

The outer pipe, 1, occupies the whole of the borehole, except for a small drainage pit, 2 (for the oil), at the bottom,

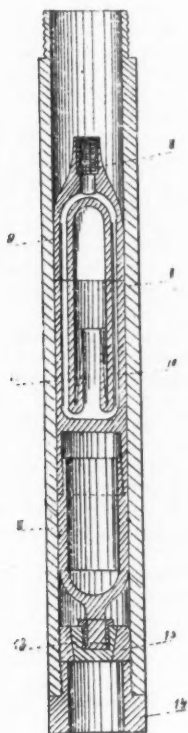


FIG. 8.



FIG. 11.

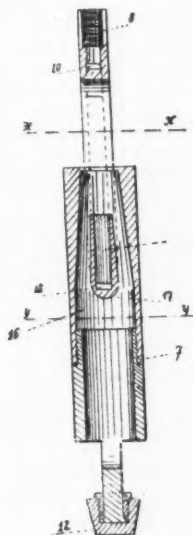


FIG. 9.



FIG. 10.

concentric pipes, the inner or air pipe being movable in a vertical direction and provided with a number of jets at intervals and a bottom valve, closing the outer or upcast pipe. Of this apparatus, Fig. 7 is a combined elevation and section, while Figs. 8 and 9 give a larger scale

while the pumping apparatus, properly so-called, is suspended on this pipe by means of the flanged collar, 3, and consists of two concentric pipes, 4 and 5, the latter serving as upcast and terminating in a pump-head, 6. The compressed air pipe, 4, communicates with an air reservoir, traverses

the pumphead, 6, and is screwed at the lower end on to a pump barrel, 7, wherein the air channel, 8, forks into two branches, 9 and 10, which again unite in a protruding nozzle, 11.

The lower end of the pump barrel carries a rotatable valve, 12, the seat of which, 13, is screwed into the pipe, 4, and kept fast by a screw, 14. The valve, 12, can be opened or closed by turning the hand-wheel, 15, screwed on to the top of the air pipe, 4.

To work this apparatus the whole is lowered, with valve 12 closed, into the borehole, and the compressed air is turned on. This latter escapes violently through the nozzles, 11, and drives the air out of the pipe, 5. On then slowly opening the valve, 12, the oil is forced by the external air pressure in the direction shown by the arrow, passes the space 16, 17, and is forced upwards by the air. As soon as the hole is emptied, the air is turned off again until a sufficient quantity of oil has collected to make it worth while starting afresh.

With this apparatus the author has raised oil from a depth of 170 metres with compressed air under a pressure of 3 to 5 atmospheres.—Victor Petit, in *Petroleum Industrial and Technical Review*.

### An Experiment in Traction.

In consequence of the alliance formed between one of the great American houses which equip electric railways and the Budapest engineers, Ganz & Co., *The Tribune* recently remarked that the world was likely to hear a good deal about the use of alternating currents for traction in the future. An additional reason for thinking so has since been afforded. At the Great Barrington meeting of the American Institute of Electrical Engineers last month Bion J. Arnold described an experiment about to be tried in Michigan. He is providing the mechanism for operating an electric road now about twenty miles long, but destined to be extended to sixty. This will be the first line in America on which the alternating current will be employed. On the Lake Como line, equipped by Ganz & Co., the high voltage employed for transmission is reduced at sub-stations before entering the motive machinery under the car. On the Berlin-Zossen line the reduc-

tion is effected by a transformer on the car itself. Mr. Arnold will follow the latter plan on his experimental road. Notwithstanding the fall in voltage from 15,000 to 200, though, the current will still be of the alternating type.

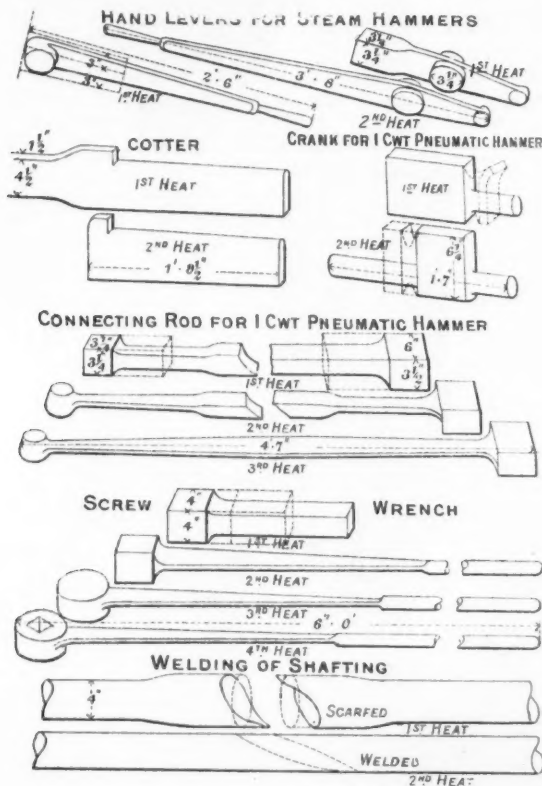
The most remarkable part of the system about to be tried is the motor. It will be unique in two particulars. Ordinarily the revolving portion of an electric motor moves only when the car is under way, and it stops when the latter does. Mr. Arnold has designed a machine resembling the gas engine which propels an automobile. This begins running before the vehicle starts, and keeps going when the carriage stops temporarily. The machinery under the electric cars of the new Michigan road will behave in the same manner, and, the inventor believes, effect a slight economy of power in consequence. The other innovation will be the combination of an air compressor with the electric motor, whereby mechanical energy will be stored when the latter is not run at the limit of its capacity. The reserve thus accumulated may be employed to supplement the motor when there is an extra demand for power, or to propel the car without any electricity at all, on a siding or in a city where the private right of way is abandoned for a short distance. In neither of these respects does Mr. Arnold's plan resemble any mechanism which has yet been tried in Europe, and for that reason the experiment is sure to prove the more instructive.

The author of this ingenious scheme is the expert who was retained a few months ago by the New York Central to formulate plans for equipping the terminal of that road in the metropolis for operation with electricity. He presented to the Great Barrington meeting an outline of his recommendations to that company. These did not call for alternating current motors. Another point of difference between them and the suggestions adopted for the Michigan line is that the latter are being carried out with the utmost expedition. Nobody seems to know when the Central will execute the programme laid out for it. From present appearances there will be ample time for Mr. Arnold to achieve a brilliant success in the West and then to advise the substitution of the new system for the one previously proposed for New York city.—*New York Daily Tribune*.

**A Pneumatic Power Hammer.**

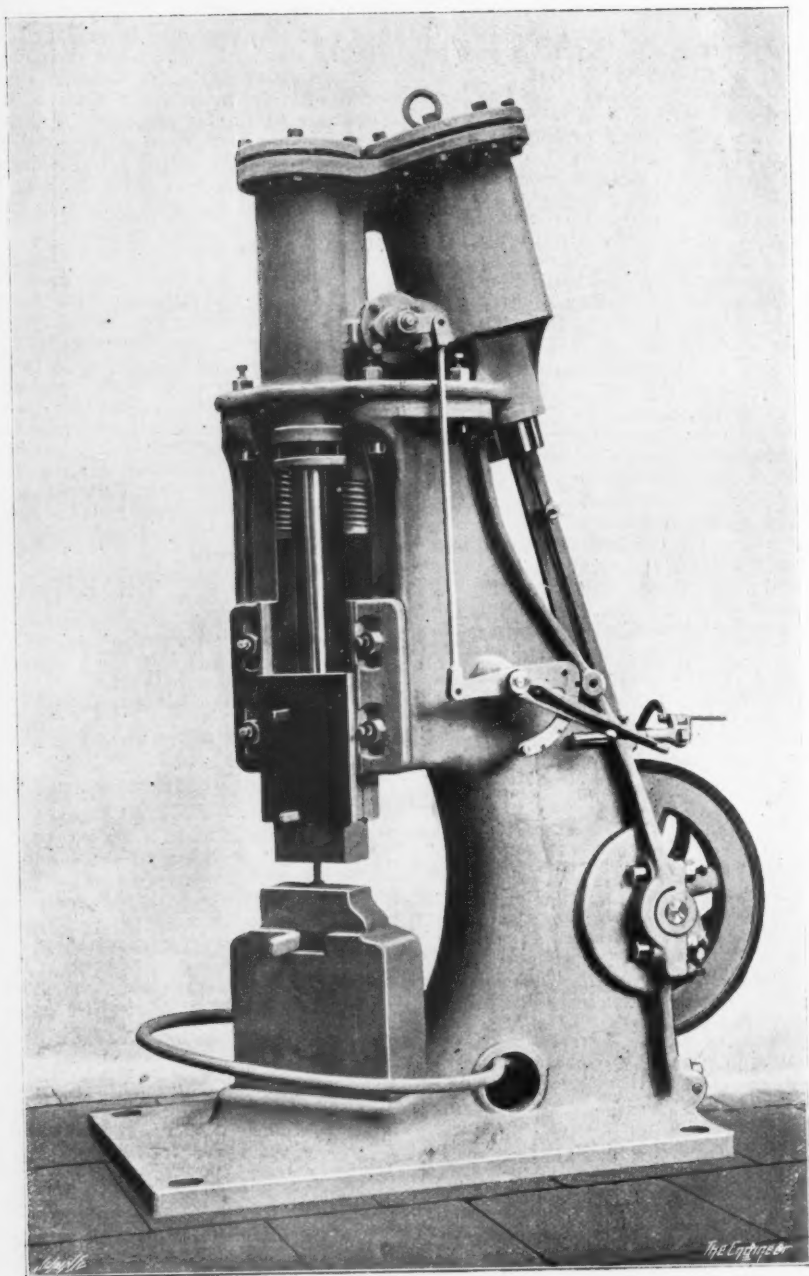
We illustrate a pneumatic hammer now being constructed by Messrs. B. and S. Massey, of Manchester. In this appliance the object has been to make a hammer that, while driven by belt power, will do actually as much work, both as to size and speed, as a steam hammer of equal weight. In the construction of the ham-

mer, and are of very compact design, so that they may be arranged within the standard. There are consequently no projecting parts, the hammer occupying scarcely more space than a steam hammer of similar capacity. A diagonal position has been given to the anvil block in order that the pallets on all sides may be accessible, and to allow of long bars being worked in either direction across



mer itself the makers have followed very closely the design of their usual smithy steam hammers, believing this to be the most satisfactory form. The hammer, instead of being operated by steam, is worked by a double-acting pump placed immediately behind, which supplies air in the place of steam at the top and bottom of the hammer cylinder at each stroke. The pulleys and crank are placed low down, in order to ensure steadiness for

the anvil. The hammer is controlled by a single valve, which is placed between the cylinders, and by varying the position of this valve by either hand-lever or foot-lever the operation of the hammer is promptly and easily regulated by the attendant. When the levers are in their top position air is forced only under the hammer piston, and the tup is held up at the top of its stroke, and remains stationary there. On either lever being depressed,



MASSEY PNEUMATIC POWER HAMMER

the air passes alternately above and below the hammer piston, and the hammer begins to work. The further the lever is depressed the heavier the blow, until the full blow is given. Thus light or heavy blows, with long or short strokes, can be struck at will, the regulations being easy, accurate, and instantaneous. As soon as the lever is released the tup rises to the top of its stroke, and remains there. Another useful feature is that the tup can be held firmly down on the anvil when it is required to use the hammer as a vice. This is frequently convenient for bending work, and for holding it during various operations. We have had an opportunity of inspecting one of these new pneumatic power hammers in operation at Messrs. Massey's smithy, and also specimens of the work done, which afforded proof of its efficiency. The work comprised all varieties of forgings; and as a test of the largest work that can be produced by a 3-cwt. hammer, as shown in illustration, a steel billet 8 in. square was drawn down at one heat to  $2\frac{1}{4}$  in. square and 28 in. long. We illustrate some examples of the class of work done by this hammer.—*The Engineer*, London.

**Compressed Air Locomotives Manufactured  
by Schweizerische Locomotiv & Ma-  
schinen Fabrik, Winterthur.**

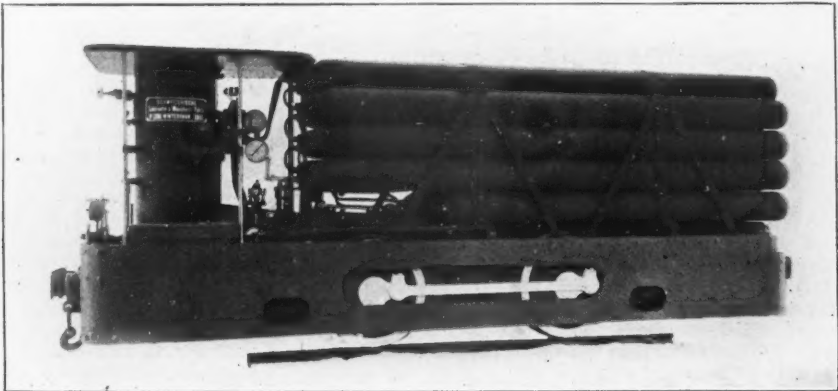
We present herewith two illustrations showing in some detail the appearance and construction of a type of compressed air

locomotive which has been adopted and is now being used in connection with the construction of the Simplon Tunnel in Switzerland.

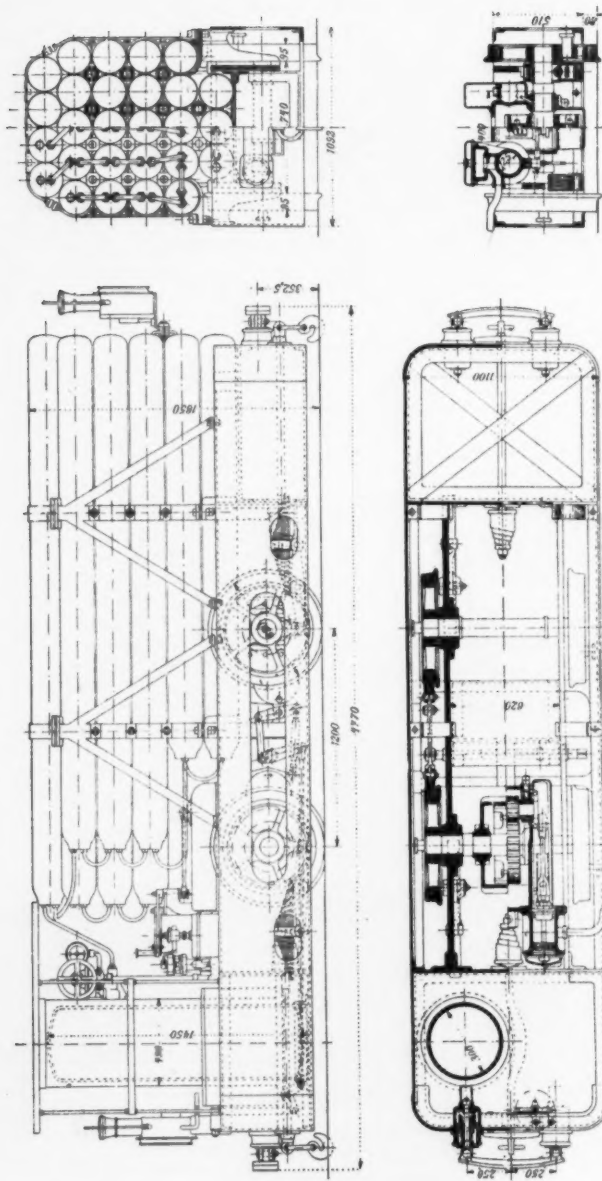
Before going into the details of this machine, it might be well to briefly review the conditions surrounding the Simplon Tunnel. It will be recalled that this is the largest tunnel in the world and is being worked from either end. It runs from Breig, Switzerland, to Isalle on the Italian side, a distance of about 13 miles, through snow-covered mountains of a height which precludes intermediate shafts. The result of this has been that unusual precautions were necessary to insure proper ventilation.

Previous to the introduction of compressed air locomotives material was handled by means of horses and steam locomotives; the steam locomotives running into the tunnel as far as the enlargement and lining had been completed, and the horses handling the cars and trucks beyond this point clear up into the headings. The cars hold about a cubic meter of material and are made up in trains at the headings or wherever enlargements are under way, and are then taken by these compressed air locomotives and hauled back to a terminal of the steam line, where they are made up into longer trains and run out of the tunnel on regular schedules.

The locomotive shaft has a substantial frame mounted on four wheels, the frame and wheels being surrounded by a protecting band, as shown very clearly in



COMPRESSED AIR LOCOMOTIVES USED IN SIMPLON TUNNEL.



DETAILS OF COMPRESSED AIR LOCOMOTIVE USED IN SIMPLON TUNNEL.

the half-tone illustration. Suspended from the frame is a single cylinder driving engine with a pinion on its shaft. The pinion meshes into a large gear keyed to the rear shaft of the truck. Connecting rods on either side connect the rear and front wheels, thus insuring maximum tractive effort. The engines and gears are encased and run in oil insuring perfect lubrication and smooth running. The working air pressure is from 10 to 15 atmospheres and even at the lowest pressures of 10 atmospheres the engine can still develop a pulling power equal to the adhesion to the rails. The gear ratio is 1:3.25. The valve gear is built according to the Joy System and reverses in the ordinary way. Suitable springs and very powerful brakes are provided and the front and rear end are provided with cushions, coupling hooks and buffers. The storage tanks or reservoir consists of a series of Mannesmann tubes mounted in layers above the frame and rigidly held in place by straps and lateral braces. The combined capacity is 70 cubic feet and the storage pressure is from 70 to 80 atmospheres. The reservoirs are connected up in such a way as to form three independent sections, so that should a leak occur in one it is only necessary to cut out this section when the engine will still have capacity enough to take it out of the tunnel or on to a siding so as not to interrupt traffic. The air passes from the reservoirs through a reducing valve whereby its pressure is dropped to from 10 to 15 atmospheres and then through a reheating tank, which is charged with superheated water, where its temperature is raised to such a point that the exhaust temperature occurs at only a few degrees above zero. In this way the efficiency of the outfit is increased and the exhaust air is of service for ventilating the tunnel.

The operator's seat is at the rear to one side of the reheating tank and all operating mechanism is conveniently placed so that he has full control of the locomotive without changing his position. Guard rails, lanterns, a whistle, and other attachments are provided making the locomotive complete in all respects and fully self-contained. The brake mechanism can be operated either by a lever or a hand screw and acts on all four wheels which insures a prompt and positive control. In operation the machine is quiet and very

satisfactory and as can be seen from the picture is rather an attractive looking apparatus.

### The Darlington Boring Machine.

This machine is claimed to be remarkable for its simplicity in construction, and for its effective working. It is worked by compressed air. The piston,  $3\frac{1}{2}$  inches in diameter, and the piston rod, only 1 inch less, are cast in one mass, and form the only working part of the drill proper. The cutting tool is fastened by means of a tightening screw into the end of the piston rod.

During the working of the drill the compressed air, admitted through the inlet port, is continually acting on the front face of the piston, and when there is no pressure on the other side the piston is driven backwards in the cylinder, and the tool is withdrawn from the face of the drill hole.

In making this movement the piston uncovers the equilibrium port, and thus establishes a communication between both ends of the cylinder. The total pressure at once becoming greater upon the back face of the piston by reason of the area for pressure being greater there, the moving mass is first arrested by this superior force, and strikes the blow. In this forward movement the front face of the piston closes the equilibrium port, and cuts off the supply of compressed air from the driving side, and soon afterwards the back face of the piston opens the same end of the cylinder to the exhaust immediately before striking the blow. These movements take place very rapidly, about 500 or 600 blows being struck per minute.

There are no valves or striking parts, and the piston is cushioned on either side of the air, which tends to safe and even working. Rotation is effected, as is usual in all modern drills, by means of a rifled bar let into the middle of the back of the cylinder, on which the piston slides, and is so held by ratchet wheels and pawls that, when the piston is making the instroke the bar is rigid and the piston is forced to turn upon it; but when making the outward stroke, being free to move in the direction that the piston has a tendency to turn it, the bar turns instead of the piston.

The feed is performed by an attendant by hand. When used in drifting or sinking this machine is fixed in the required position upon a cross-bar, which is made rigid by its ends being forced into the sides by means of telescopic pins or screw pins. The best and most expeditious arrangement, however, when used for drifting, is to attach the drill or drills upon a carriage made to run upon rails, and held rigid when working by screw pins in a similar way as described. In drifting, the drills are used in pairs, one on each side of the drift. The machine is connected with the compressed-air supply pipe by means of a few yards of flexible tubing.

The machine above-named is not intended to bore holes more than 6 feet in depth, and from 1 inch to  $2\frac{1}{2}$  inches in diameter; the boring is done at a speed of from 2 inches up to 9 or 10 inches per minute in granite. To bore a hole 3 feet deep in 15 minutes, including changing the drill bar, would be very good work for ordinary practice; it would very likely take two hours for three men to bore a similar hole by hand.

Compressed air from 30 to 60 lbs. pressure per square inch is generally used, and is useful after blasting to clear away the smoke, and, if the mine is hot, in cooling the heading.—*Science and Art of Mining.*

### Velocity of Air Flowing Under Pressure.

A correspondent writing to *Mines and Minerals* gives this example: At what velocity will air flow from a tank having a gauge pressure of 100 lbs., into a tank having a gauge pressure of 80 lbs., through a short pipe connecting the two tanks? Find the velocity, also when the gauge pressure in the tanks is (b) 100 pounds and 60 pounds; (c) 100 pounds and 40 pounds; (d) 100 pounds and 20 pounds. *Mines and Minerals* publish the following reply:

In the flow of a compressible fluid the velocity head is equal to the pressure head causing the flow multiplied by a coefficient. The pressure head causing the flow is the difference between the initial and terminal heads. The equation is expressed as follows:

$$\frac{v^2}{2g} = \frac{r}{r-1} \left( \frac{p_1}{d_1} - \frac{p_2}{d_2} \right); \quad (1)$$

in which  $v$  = velocity of flow (ft. per second);

$g$  = force of gravity (32.16 ft. per second);

$r$  = ratio between specific heats of air at constant pressure and constant volume (1.405);

$p_1$  = initial pressure (lb. per sq. ft.);

$p_2$  = terminal pressure (lb. per sq. ft.);

$d_1$  = density of air at initial pressure (lb. per cu. ft.);

$d_2$  = density of air at terminal pressure (lb. per cu. ft.).

By deductions from Gay-Lussac's and Mariotte's laws, we have,

$$\frac{p_1}{d_1} = \frac{p}{d} \frac{T_1}{T}; \quad (2)$$

in which  $p$  = any pressure (lb. per sq. ft.);

$T$  = any absolute temperature;

$d$  = weight of 1 cubic foot of air at pressure  $p$  and absolute temperature  $T$ ;

$T_1$  = absolute temperature of air in first tank.

Combining equations 1 and 2, and performing certain transformations, we have,

$$\frac{v^2}{2g} = \frac{p}{d} \frac{T_1}{T} \frac{r}{r-1} \left[ 1 - \left( \frac{p_2}{p_1} \right)^{\frac{r-1}{r}} \right]. \quad (3)$$

But the weight of 1 cubic foot of air at a temperature of 60° F. and a barometric pressure of 30 inches is .0766 lb.; hence, we may assume  $d = .0766$  lb.;  $p = 30 \times .49 \times 144 = 2,116.8$  lb. per sq. ft.; and  $T = 459 + 60 = 519^\circ$  F. Then substituting given values for  $p$ ,  $d$ ,  $T$ ,  $g$ , and  $r$ , we have, after reducing,

$$v = 109 \sqrt{T_1 \left[ 1 - \left( \frac{p_2}{p_1} \right)^{.29} \right]} \quad (4)$$

(a) Substituting the given values in equation 4,  $p_1 = 100 + 15$ ;  $p_2 = 80 + 15$ ; and assuming the temperature of the air in the first tank  $T_1 = 459 + 80 = 539^\circ$  F., we have,

$$v = 109 \sqrt{539 \left[ 1 - \left( \frac{80 + 15}{100 + 15} \right)^{.29} \right]} \\ = 587 + \text{ft. per sec.}$$

Likewise substituting the given values in equation 4, we obtain for the velocities

of flow in each of the other cases, (b)  $v = 864 +$  ft. per sec.; (c)  $v = 1,055 +$  ft. per sec.; (d)  $v = 1,360 +$  ft. per sec.

The free spaces, which are incorrectly called "prejudicial spaces," reduced as they may be in well-designed compressors and for the pressures usually adopted, do not exert any great influence on the industrial yield of air-compressors, their only effect being to cause a very slight increase in the volume delivered. The arrangements of compressors based on the suppression or compensation of dead spaces have not, in fact, owing to this circumstance alone, any superiority over those of other types; and not only so, but even the compensation of dead spaces, as it has been applied in some compressors, consisting in exhausting the spaces at the ends of the stroke by making communication between the two piston faces, leads to a loss of power in consequence of the non-restitution of the compression work stored up in these spaces. The slight reduction in the dimensions of compressors resulting from the compensation of dead spaces is certainly insufficient to compensate, by the insignificant diminution in friction which results from it, the inevitable increase of work on the compressing piston.

The above-named loss of power has been determined by Burckhardt & Weiss, who, in their treatise on the subject, give the following table, showing for a given weight of air drawn in and for different ratios of compression, the theoretical work developed on the compressing piston both with and without compensation of the dead spaces:

RATIO OF COMPRESSION.	THEORETICAL WORK ABSORBED BY THE COMPRESSOR.	
	Without Compensation.	With Compensation.
Dead Space: 0.07.		
2	1.00	1.04
3	1.00	1.07
4	1.00	1.11
5	1.00	1.16

#### Ozone for Sterilization of Water.

When the question comes up as to the purification and sterilization of a city's water supply, the cheapest and best plan is to make the ozone yourself and utilize

it immediately, at least, this is what Mr. F. Regaud, of *Mining and Scientific Press*, tells us, and we quote his own words:

"The following is a description of the operation and scheme of its organization: It is necessary to use fresh, cold air. In case it should be impossible to obtain air below 60° F., it is necessary to cool the flow of air before its ozonization by passing it through pipes enclosed in ice or by refrigeration by some process.

"The water must be under about one-half atmospheric pressure and the purification must take place under this pressure. The air is deprived of moisture by caustic alkali. In the accompanying diagram A is the air compressor, B the drier, C the cooling chamber.

"The quantity of air to pass into the ozonator D is about one gallon to ten gallons of water to be treated, or 33,000 cubic feet daily, in our type—385 cubic feet per second, under pressure of 20 inches of mercury.

"The ozonator may be constructed on several plans, the principle alone being fixed. It contains a large number of small cells, each of which is formed by two surfaces of glass. The exterior sides of their surfaces (plates or cylindrical) are covered with metal—tin or copper—or are in contact with pieces of iron, and the surfaces respectively are connected by wires with the two poles of an electrical alternator E and transformer F, giving at least 40,000 volts pressure. The electrical engine furnishing electric current for our type is a 30 H. P., producing daily about 14 pounds of pure ozone.

"Between the surfaces of glass runs slowly the air sent by the compressor, and it acquires about ½ % of pure ozone as a result of this indirect electrization. Then the air goes directly to a tower G, or, more exactly, three or four towers (about 15 feet high), whose diameter is calculated to provide 15 seconds for the water to pass through. The aim of this disposition is to assure perfect mixture of ozonized air at ½ % ozone with water during 15 seconds.

"The variables in the operation are the amount of air furnished and the number of turns at the electric engine. Regulation is made by accurate bacteriologic examination of water flowing from the

tower. The indications we have given above appear like a maximum, except in extraordinarily impure and dangerous water.

"The result is absolutely perfect and marvelous. Examination of water arriving at the aerator, in the experiment to which I refer, gave about 60,000 bacilli colonies to the cubic inch. After 15 seconds mixture it was not always easy to find any microbes, but the estimation was 20 or 30 all non-noxious.

"On the other hand, when taking water in a pipe 6 feet long, terminated by two glass plates, it was difficult to see light through the water arriving. After treatment the transparency was complete; and, tasting the two kinds of water, I found a big difference. The first one was insipid, the second very agreeable to drink. And this experiment is not the least one, because the taste is a better analyzer than some chemists and scales.

"From the experiments I made, and confirmed by other observations, the plant for this operation will cost about \$20,000 for the type treating 2,500,000 gallons of water daily.

"The necessary current expenses are the cost of running an engine of 25 to 30 H. P. and the maintenance of all apparatus in perfect shape. From our experiments the direct expense was 1 cent for 5,000 gallons, or \$5 daily for the 2,500,000 gallons. The cost of maintenance for the \$20,000 plant may not be far from the same figure; but for general expenses it is difficult to foresee everything without knowing the special indications. If the purification is connected with pumping, the general expenses will be low, the salary of an engineer only; but if the operation is separate the cost may be very high. I think as a provisional figure, under various circumstances, the price may be between 2 and 5 cents to 5,000 gallons; but the above figure, applied with care, allows anyone to make an exact estimate in given circumstances.

"The important point is constantly made that air at  $\frac{1}{2}\%$  ozone, in contact during 15 seconds with impure water, transforms this liquid into a perfect beverage."

## Notes.

The man who invents an airship with a safety clutch and something for it to clutch to will solve the problem all right.

The McKiernan Drill Co. has removed their office to 170 Broadway, New York City. They report having secured some contracts from Norway and China.

A water-power hoist, air compressor and other machinery are to be immediately put on the What Cheer Mine, owned by John Landers, of San Francisco, Cal.

The Cleveland Pneumatic Tool Company have appointed the Compressed Air Machinery Company, of San Francisco, Cal., their representatives on the Pacific coast.

Pneumatic drills range in weight from 14 to 35 pounds, and drill from  $\frac{1}{4}$  to 2 inches with from 3 to 4 inches feed, and require pressures from 80 to 100 pounds, with a consumption from 20 to 45 cubic feet of free air per minute.

The Pneumatic Horse Collar Company, of Holland, Mich., is to fit up a factory there for that line of manufacture. The officers include: President and general manager, G. W. Browning; vice-president, J. C. Post; secretary, A. Visscher; treasurer, Charles H. Browning, of Battle Creek.

In the reports from the mines of the Yorkshire and Lincolnshire districts, England, returns showing the amount of coal cut by machinery have been furnished by a number of owners. These returns show that 85 machines were at work, 63 being driven by compressed air and 22 by electricity, and that 956,230 tons of coal in all have been cut within the last year.

The Columbus Pneumatic Tool Co. Columbus, Ohio, have issued a pamphlet on the U. & W. Piston Air Drill upon which this company have based a number of statements showing the peculiar conditions of work for which this air tool is particularly adapted. Eight fine

half-tone engravings in the pamphlet illustrate the application of this drill in difficult locomotive and boiler work.

Mention of the first employment of pneumatic tools in Cramps' shipyard inspired one of the Chicago Pneumatic Tool Company's representatives to disclose the fact that Cramps now have an air plant compressing 15,000 cubic feet of free air per minute and use over 1,200 pneumatic hammers, drills and riveters, all furnished by the Chicago Pneumatic Tool Company.

A trial of pneumatic tires for motor cars is being organized by the Automobile Club, and will take place during four weeks in September. The distance to be covered will be 3,000 miles, in sections of 150 miles per day. The cars on which the tires are to be fitted are to weigh not less than 30 cwt., and must be propelled by petrol engines of at least 10 horsepower. Valuable prizes are offered.

Compressed air for pumping oil wells is to be tried in connection with some of the Beaumont wells that have lately ceased to "spout." The Spindle Top Power Co. is reported as having commenced the erection of an enormous compressed air plant, and it proposes to sell the product to those needing it. Compressed air has already been successfully tried on a small scale as a substitute for gas pressure.

The compressor for the United States Mining Company, at Bingham, Utah, is from the works of the Allis-Chalmers Company. The size of the machine is as follows: Steam cylinders, 22 and 40 ins. in diameter; air cylinders, 36 and 22 ins. in diameter, all 40-in. stroke. The compressor runs condensing and compounds the steam and air cylinders, delivering about 3,400 cu. ft. of free air per minute.

The Librarian of Congress, Washington, D. C., writes that they are short of several numbers, which they are very anxious to have in order to complete the file of COMPRESSED AIR for the Congressional Library. If any of our readers can furnish any of these numbers, a list of

which we give below, it will be very much appreciated:

Volume 1. Nos. 5, 6, 7, 8, 9, 10, 12.

Volume 2. Nos. 1, 2, 3, 5, 6, 7, 8.

Volume 3. Nos. 2, 3, 4.

The Cleveland Pneumatic Tool Company, Cleveland, Ohio, have purchased a tract of land on Hawthorne and Second avenues, and will at once begin the erection of modern factory buildings. They have outgrown their present shop space, and are unable to keep up with their orders. They will employ about 150 men in their plant, and hope upon its completion to be in a position to serve the trade more promptly than at present. Electrical power will be used in driving the machinery.

It is with pleasure that we note the little red pamphlet, "Circular E," sent us from the Abendroth & Root Mfg. Co., 99 John St., N. Y., manufacturers of spiral riveted pipe and water tube boilers. "He who runs may easily read" (for these few words on the cover tell their own story well). "Brooklyn factory destroyed by fire July 24th, 1901; new works at Newburgh opened December 1st, 1901;" and we find rising up before us an admiration for so much "go-aheadness" and prompt action.

Pedrick & Ayer, Philadelphia, Pa., builders of air compressors, pneumatic riveters, hoisting machinery, railroad tools, etc., have recently received orders for tools from the Canadian Pacific and for a pneumatic riveter, with 16-inch throat and 54-inch reach, for the Central Railroad of New Jersey. The company will remove its works from Philadelphia to Garwood, N. J., the plant at the latter point including two machine shops, 520 by 100 feet and 620 by 100 feet, together with power house, storehouse, etc.

The Lady Engineer Again.—A press note says: "Miss Alverda M. Stout, of Columbus, Ohio, although but 18 years of age, is a mechanical engineer and among the most competent members of that craft." Should the young woman's duties at some time require her to cull a few indicator cards from a locomotive going at a 75-mile clip there might be some

difficulty in keeping the hat on straight. But let us hope that Nature would be so startled that it could be said "and all the air a solemn stillness held."

The Paris Compressed Air Company, which several years ago subordinated its compressed air branch to that of the supply of electric light, continues in an unsatisfactory condition. During the past financial year the gross profits amounted to £146,185, of which £5,267 was derived from the compressed air department, and the net profits reached £99,066, as against £81,200 in the preceding year. The net profits have as hitherto been transferred to the special account for the redemption of the capital expenditure, thus increasing this item to £235,334.

In a safety arrangement for winding cages, patented by Theodor Eichhorn, Königshütte, Upper Silesia, brake shoes on the outer ends of piston rods are pressed outwards against the inside faces of the guides, by means of gas or compressed air admitted between two pistons moving in a horizontal cylinder underneath the cage; and there is an arrangement in the cage itself for admitting the gas or compressed air into the cylinder by means of a valve, and also of permitting the cage to be braked down against the guides, independently of the rope in the event of its having given way. This device was suggested in COMPRESSED AIR.

Mr. Frederick Walker, of Oxford, England, is to design a new air yacht for M. Panuzzi. It will be 230 ft. long, with frame similar to that of an inverted ship and with a rigid car. The twin propellers, 11 ft. in diameter, and forward and above the centre of gravity, are driven by electric motors through a dynamo attached to the spindle of a turbo-petrol motor of special design and 55 H. P. Compressed air, used with the petrol, will keep the temperature very low, and it is estimated that the vessel will attain a speed of twenty-five miles an hour. This is the second largest airship laid down in England, and the inventor says it is by no means an aerial toy.

The Corrington Air Brake Company, of New York city, was incorporated in Al-

bany, N. Y., recently with a capital of \$5,000,000 to manufacture air, electric and other brakes and appliances for locomotives, cars and vehicles. The directors are John N. Beckley, Frederick Cook and John F. Alden, of Rochester; K. W. Blackwell, of Montreal; Elias Rogers, of Toronto; Henry M. Watson, of Buffalo; John P. O'Donnell, of London, England, and William G. Choate, Coleman Hanford, Nelson Shipman, Joseph Larocque, Jr., Charles F. Gehrmann, Charles Hansel, Clarence A. Hope and Murray Corrington, of New York city.

A new air compressor was patented by E. Josse, Charlottenburg, Germany, and accepted April 9, 1902. This air compressor is intended for highly compressing air in one operation, comprises an outer casing partly filled with oil, a cylinder, two pistons, a valve or valves for suction in one or both of the pistons, a delivery valve in the cylinder or in one of the pistons, and connecting gear. The two pistons are within the one cylinder, and are arranged to move in opposite directions with the object of improving the balance of the engine and minimizing the total clearance space in proportion to the total cylinder content. In one apparatus there is a suction valve in one cylinder and a delivery valve in the other.

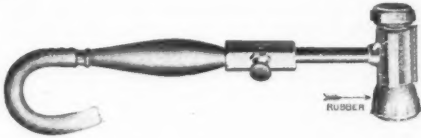
Where there is already a reservoir and general equipment for compressed air, tools around a shop it will be found very convenient sometimes to use the air pressure to run the steam hammer, if it be not too large.

I have seen this means employed on a hammer in the forge shop of a large concern where they employed all sorts of compressed air tools, and they had a long radius elbow on the exhaust pipe which was located so that it could be readily directed on the anvil, keeping it free from dirt and scale at all times. The man who operated the hammer said it was a very convenient scheme and that they used the 80-pound pressure from the regular reservoir.

Baldwin's Vibrator Mallet consists of a pneumatic vibrator at right angles to a handle and is intended for use when very quick blows are required. The one illustrated here is for foundry use, one

face being covered with rubber so the pattern itself can be rapped if necessary.

In use the mould is rammed as usual and after draw spike has been inserted in pattern the metal face is placed against the spike and the valve in the handle opened with the thumb. As the piston



makes several hundred strokes a minute a very quick vibration is communicated to the pattern which enables it to be drawn more quickly and with less enlargement of mould than when the old style of hand rapping is used.

Instead of the rubber face any tool desired may be inserted in a proper holding device.

These mallets are manufactured by the Power Specialty Company, 126 Liberty street, New York city.

The Philadelphia Pneumatic Tool Company is now entirely settled in its new shops, at Twenty-first street and Allegheny avenue, Philadelphia. Considerable loss of time naturally resulted from moving and the company reports being somewhat behind in making shipments. The works are being run night and day, however, to catch up, and orders will be filled with usual promptness at no distant date.

A great deal of attention is being attracted to the Keller Pneumatic Hammers, made by the Philadelphia company, by reason of a recently devised improvement in their construction. On account of this improvement the working capacity of the Chipping and Riveting Hammers is increased at least 25 per cent., and the vibration, inseparable from any pneumatic tool, is reduced very materially. This applies to both Chipping and Riveting hammers.

Recent large orders have been received from the Southern Pacific Co., Newport News Shipbuilding and Dry Dock Co., Pennsylvania Railroad Co., Lackawanna Steel Co., and others.

The latest application of compressed air is a vacuum carpet and upholstered furniture cleaner, which has been perfected by the Vacuum Cleaner Company, Ltd., of 25 Victoria street, S. W. A vacuum is established by means of an air pump operated in a portable truck, which carries the entire plant, and the suction of air created by this means is carried to the carpet or furniture being treated, through flexible india-rubber tubes, with the result that by passing the cleaner over the floor, the dust contained in and under the carpet is drawn up by the great suction pressure, and is removed along the tube to a filter attached to the truck, where the dust is collected and deposited. The nap of the carpet is raised by this treatment, and carpets trodden down by much traffic again become soft and bright in color. The operation is quick and quiet, and, most important of all, no dust is driven into the air by the cleaner, which, if disturbed and not collected, would ultimately resettle on the carpet. So thorough is the removal of the dust that not only is the dust on the carpet removed, but also dust from underneath the carpet, so that when the treatment is complete both carpet and underfelt are free from dust. The same process with a different form of cleaner is applied to upholstered furniture.

The Allis-Chalmers Co. write as follows:

"We have been compelled by the large volume of orders on our books, to make additions to our plants and install additional machinery to enable us to take care of the business offered. We are now in shape to give prompt service and the very best results.

"The Allis-Chalmers Co., comprising the Edw. P. Allis Co., Milwaukee, Wis.; Fraser & Chalmers, Chicago; Gates Iron Works, Chicago; Dickson Mfg. Co., Scranton, Pa., is, without doubt, the largest company in the world devoted to the manufacture of mining and metallurgical machinery, and in consequence of this consolidation we are placed in a position to give our customers the benefit of all knowledge, improvements and conditions brought about by the change,

which will enable us to specialize our work to a degree that will assure prompt attention to all orders.

It is the aim of the Allis-Chalmers Company to produce the best machinery for the particular purposes intended. When we speak of the "best," we do not necessarily mean the most costly. Even though the best material is used, and the workmanship the most perfect of its kind, it is only when the whole product is appropriate to the purpose intended that it is entitled to be termed the best.

"Our experience enables us to design and execute what will best serve your particular needs at a minimum cost. We shall be pleased to receive advices from you as to your requirements, assuring you of our determination to merit your continuous patronage."

A comparison between Schütz two-stage air-compressors, one with self-acting valves, at the Centrum Colliery, Westphalia, and the other with actuated oscillating valves at the Fröhliche Morgensonne, shows that the volumetric yield is intimately connected with the speed of running. The differences of pressure required to open and keep open the valves increase, on account of the increasing friction of the air volumes passing through them, with the piston speeds; and the closing of the valves is progressively delayed in comparison with the positions of the piston corresponding with the various periods of work. With Köster oscillating valves, on the contrary, the volumetric yield is not affected by the speed, because the valve-gear is arranged for openings and closings of the passages corresponding with suitable positions of the piston. In the course of time the compressor with self-acting valves leaves much to be desired as regards the air volume delivered on account of the many places of contact in the valves which in normal working are not constantly kept tight and this in direct ratio to the speed, whereas with oscillating cylindrical valves it occurs to a far slighter extent; and herein consists the superiority of compressors with positively actuated valves. Inasmuch as there is no material difference in the first cost of the two types, one would not at first be inclined, especially for usual speeds, to give an unqualified preference to one of them over the other; but the case is

far different when it is required to decide whether greater importance should be attached to a slightly greater simplicity in the self-acting valves or to the superior efficiency of those positively actuated. With oscillating cylindrical valves, as compared with other types, dead spaces may be reduced to a minimum; and the simple manner in which the Köster valves are actuated ensures for them an advantage similar to that afforded by Corliss valve-gear in steam engines. Thus concludes Engineer Goetze, of Bochum, in a communication to *Gluckauf* on the volumetric yield of air-compressors.—*Colliery Guardian*.

The St. Charles of Milwaukee is the first hotel in the world to install a permanent plant for cleaning house by compressed air. As this method of cleaning possesses many novel features, and the claim is made by the company controlling it that it is superior to all others and that it controls the fundamental patents for cleaning carpets without removal from the floor, the editor of the *Hotel Monthly* was sufficiently interested to make a special trip to Milwaukee to see the new plant in operation. Mr. F. J. Matchette, proprietor of the St. Charles Hotel, showed the plant in detail, explained the workings and gave a practical demonstration in one of the long halls of the hotel.

In the basement of the hotel there is an air compressor of the Christensen type operated by electric motor. Mr. N. A. Christensen, inventor of this motor and one of the foremost authorities on pneumatics in the United States, is president of the American Compressed Air Cleaning Company, who installed this plant. Nearby are two seamless steel air reservoirs, into which air is compressed and maintained to the desired pressure (usually 60 to 85 pounds to the square inch), this being regulated by an automatic governor which starts the motor when the pressure is below, and stops it when it is above, a given point. The compressed air is led from the reservoirs to the floor above by means of a 3/4-inch iron stand pipe, which rises in the elevator shaft and which has hose connections on each floor. Hose (one-half inch) is attached to this stand pipe and run to any part of the floor where cleaning is to be done. The patented de-

vice for cleaning the carpets is about the size of a Grand Rapids carpet sweeper—a trifle larger perhaps—and weighted so as to keep it close down to the floor. Underneath are two steel rollers, one to the front and the other to the rear. Midway between the rollers is a tiny orifice extending across the machine, the mouth so fine that a knife blade can barely be inserted. Along each side of this orifice are larger openings into the machine, where is kept a removable dustpan.

In operation the air delivered to the machine through the hose is driven through the small mouth with such force that, striking downward into the carpet, it dislodges every particle of dust, even that under the carpet, and the power of the blast is such that the dust must escape. The only avenue of escape is through the larger openings at either side of the small mouth, and here it is imprisoned in the dustpan. The air itself escapes into a dust-proof bag, attached to the top of the machine and which, while the machine is working is inflated like a balloon. The machine is pushed over the carpet backward and forward the same as a carpet sweeper, the blast getting in its work both on the forward and back strokes.

To give an idea of the power of the blast, Mr. Machette tilted the machine and asked the visitors to put their hands over the escaping air. It was a concentrated hurricane. He turned the blast towards the carpet and the air was filled with fine dust, in appearance as a cloud of steam. He took a cupful of flour, sprinkled it over the carpet, trod it in thoroughly, ran the machine over it and the flour disappeared, leaving the carpet clean.

There are devices for dislodging dust from corners and crevices, from curtains and furniture, from billiard cloths and from walls and ceilings, but the collecting of dust is mainly that from the carpet.

Mr. Matchette explained that it was economy for a large house to install its individual plant, so as to have compressed air always on tap and permit of a continuous housecleaning of so many rooms or halls a day, year in and year out. For a small house, where the expense of installing a private plant might not be warranted, the suggestion is made that what he calls the "wagon or portable plant" can be adopted. In this way a wagon equipped

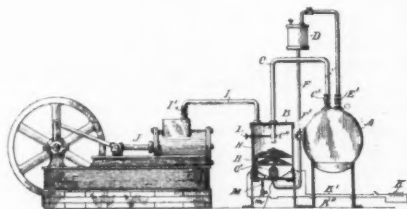
with the necessary compressor, a gasoline engine, a few lengths of hose, and the necessary paraphernalia for cleaning, is made available not only for the hotel, but also for cleaning private residences, public buildings, etc., a wagon with two or three men having an earning capacity sufficient to pay a large income on the amount invested.

Exclusive territorial franchises for operating these wagons are sold to responsible parties. In many cities throughout the country hotel men are becoming interested in this plan for the reason that it affords them a way to have their hotels cleaned by compressed air without the expense of installing a stationary plant, besides an opportunity for a safe and good-paying investment.

## U. S. PATENTS GRANTED MAY, 1902

Sp. cially prepared for COMPRESSED AIR.

699,156. COMPRESSED AIR-HEATER. Chas. B. Duncan, New York, N. Y., assignor to John C. Henderson, New York, N. Y. Filed Jan. 12, 1901. Serial No. 43,024.



A compressed-air heater, the combination with a motor adapted to be driven by compressed air, of a compressed air chamber, an expanding-chamber provided with an air-inlet, a burner within the expanding-chamber for heating the air, and wire screens arranged in the expanding-chamber and interposed between the burner and the air-inlet.

699,166. APPARATUS FOR PURIFYING AIR. David Grove, Berlin, Germany. Filed May 29, 1899. Serial No. 718,736.

699,288. AIR-COMPRESSOR AND INTER-COOLER. William B. Cowles, Cleveland, Ohio. Filed Aug. 16, 1901. Serial No. 72,529.

An apparatus of the character described, the combination of a heating and cooling

tank, a reservoir for compressed air, means for supplying compressed air to said reservoir including a cooling-coil in said tank, and means for carrying off air from said reservoir at a reduced pressure, including a heating-coil in said tank.

699,405. SAND-BLAST. Ray C. Newhouse, Columbus, Ohio. Filed Dec. 10, 1901. Serial No. 85,399.

A sand-blast comprising a casing, frusto-conical partitions arranged within the casing at different points and forming upper and lower sand-chambers, a blast-pipe connected with the lowermost partition, valves arranged at the other partitions, an air-supply pipe connected with the blast-pipe and with the individual chambers, and means for connecting the chambers and the air-supply pipe individually or simultaneously.

699,570. AIR-COMPRESSOR. George W. Rhine, Altoona, Pa. Filed Jan. 8, 1902. Serial No. 88,856.

An air-compressor, the combination with a stationary disc, of an annular air-chamber surrounding the disc, an annular casing between the disc and air-chamber, a series of pump-cylinders supported within the casing, a revoluble shaft extending loosely through the disc, wheels fixed upon the shaft on opposite sides of the disc grooved cams secured to the inner sides of the wheels, and pump-pistons provided with rollers adapted to travel within the grooves of the cams.

699,680. PNEUMATIC SHOVEL. Lafayette Hanchett, Idaho Springs, and William C. Davis, Denver, Colo. Filed Dec. 12, 1901. Serial No. 85,715.

A power-shovel, a carrying-truck, a turntable mounted thereon, guides on said turntable, arms slidingly and pivotally supported from said guides, a shovel carried by said arms, means for advancing and retracting said arms, and means connected to said arms for raising and lowering them.

699,838. SAND-BLASTING APPARATUS. Myron E. Evans, New York, N. Y. Filed Sept. 5, 1899. Serial No. 729,480.

A sand-blast apparatus a nozzle-body, consisting of an air-chamber, an inner nozzle, and a detachable outer nozzle, the adjacent

surfaces of said air-chamber and said inner nozzle forming an annular opening when said outer nozzle is detached, and the adjacent surfaces of said inner and outer nozzles forming an annular opening when said outer nozzle is attached.

700,239. PNEUMATIC SHEET-CARRYING DEVICE. George F. Read, New York, N. Y., assignor to Robert Hoe, New York, N. Y. Filed July 29, 1901. Serial No. 70,077.

700,519. AIR-HEATER. Arthur H. Lovejoy, Galia, N. J. Filed Dec. 17, 1901. Serial No. 86,208.

700,607. SENDING APPARATUS FOR PNEUMATIC-DESPATCH SYSTEMS. Birney C. Batcheller, Philadelphia, Pa. Filed July 31, 1901. Serial No. 70,328.

A pneumatic-despatch system, a sender connected to a transmission tube in combination with outer and inner gates adapted to open under the pressure of an inserted carrier, means for closing said gates when the carrier has passed them and means actuated by the insertion of a carrier into the sender for connecting the sender with an air-receptacle having substantially the pressure of the transmission-tube for the purpose of equalizing pressure on the inner gate.

700,628. MINING-MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, Columbus, Ohio. Filed Oct. 14, 1896. Renewed Oct. 29, 1901. Serial No. 80,460.

The combination with the bed, the carriage, resting upon and sliding along the bed and the laterally-acting chain having cutters mounted upon and advanced by the carriage, of the rotating holder mounted at the front of the carriage, and adapted to engage with the horizontal wall of the coal-kerf, and a support for said rotary holder adapted to be adjusted in position vertically.

700,664. HOT-AIR FURNACE. Marion Lee and William W. Bryan, Angola, Ind., assignors to William M. Fanning, Angola, Ind. Filed March 22, 1901. Serial No. 52,362.

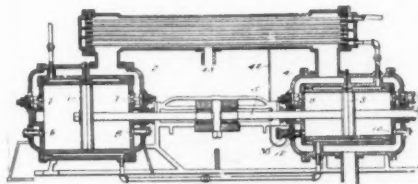
700,840. PNEUMATIC TIRE. Enos Smith, Vernham Dean, near Hungerford, England, assignor to John Smith, Troy, N. Y., and Harry Smith, New York, N. Y. Filed April 12, 1902. Serial No. 102,510.

700,842. PNEUMATIC MALTING-DRUM. Henry Smith, Milwaukee, Wis. Filed Dec. 24, 1900. Serial No. 40,849.

700,858. AIR PURIFYING AND COOLING APPARATUS. Richard H. Thomas, Chicago, Ill. Filed April 18, 1901. Serial No. 56,507.

700,859. AIR PURIFYING AND COOLING APPARATUS. Richard H. Thomas, Chicago, Ill. Filed May 21, 1901. Serial No. 61,280.

700,927. AIR-COMPRESSOR. Ebenezer Hill, South Norwalk, Conn. Filed August 17, 1901. Serial No. 72,349.



A compound air-compressor having cylinders, pistons, inlet and discharge valves and cylinder-interduct, means for opening a valve of the second cylinder, and a passage so connecting said interduct with the valve-opening means that the pressure in the cylinder-interduct controls the operation of the valve-opening means.

700,995. AIR-FORCING DEVICE FOR ATOMIZERS. Charles J. Walz, New York, N. Y., assignor to West Disinfecting Co., New York, N. Y., a corporation of New York. Filed March 20, 1901. Serial No. 51,968.

701,074. AIR-CLEANSING AND COOLING DEVICE. Joseph McCreery, Toledo, Ohio. Filed Feb. 5, 1900. Serial No. 4,001.

701,130. APPARATUS FOR TESTING THE VOLUME OF AIR FROM THE LUNGS. Michael Benedict, New York, N. Y. Filed July 23, 1901. Serial No. 69,347.

701,163. COMBINED AIR AND WATER PUMP. Edward D. Deeter, Milford, Ind. Filed Feb. 23, 1901. Serial No. 48,466.

A pneumatic system for water elevation, a sealed tank, a water-service leading therefrom, a pump comprising a cylinder having an out-

let connected with the tank, a water-pumping device consisting of a plunger-rod, and a head thereon having means for the upward passage of water and air, an air-induction device coacting with the water-pumping device and having a valve for controlling the amount of air pumped, and adjustable devices for controlling the movement of said valve.

701,205. AIR-BRAKE FOR RAILWAY CARS. Forest M. Kreltz, South Bethlehem, Pa., assignor to William N. Miller and William J. Rau, South Bethlehem, Pa., Filed Aug. 19, 1901. Serial No. 72,617.

701,228. AIR-DIFFUSER. Stephen G. Smith, Hannibal, Mo. Filed Nov. 25, 1901. Serial No. 83,607.

701,272. AIR-BRAKE CONNECTION. William Nell, Newark, N. J. Filed June 7, 1901. Serial No. 63,601.

11,994. PNEUMATIC STRAW-STACKER. John M. Andrews, Andrews, Tenn., assignor of two-fifths to A. P. Roberts and C. P. Roberts. Filed Feb. 7, 1902. Serial No. 93,092. Original No. 669,500, dated March 12, 1901.

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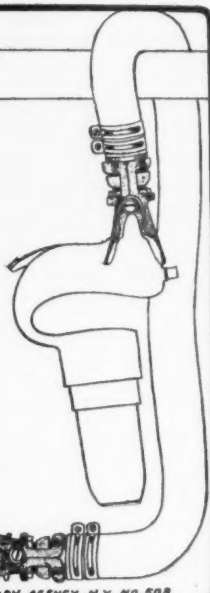
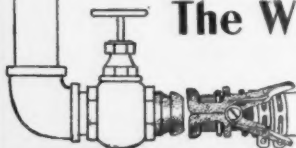
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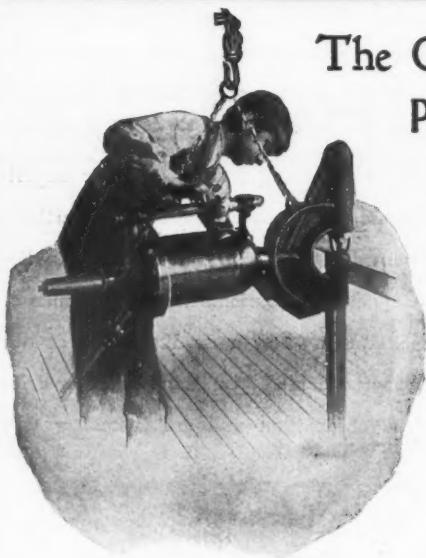
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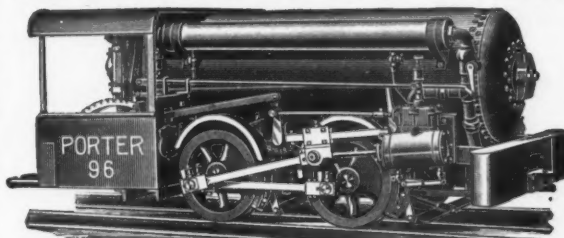
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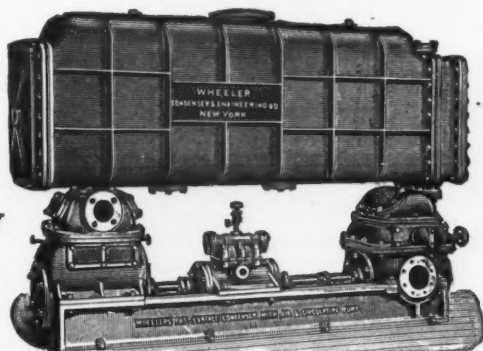
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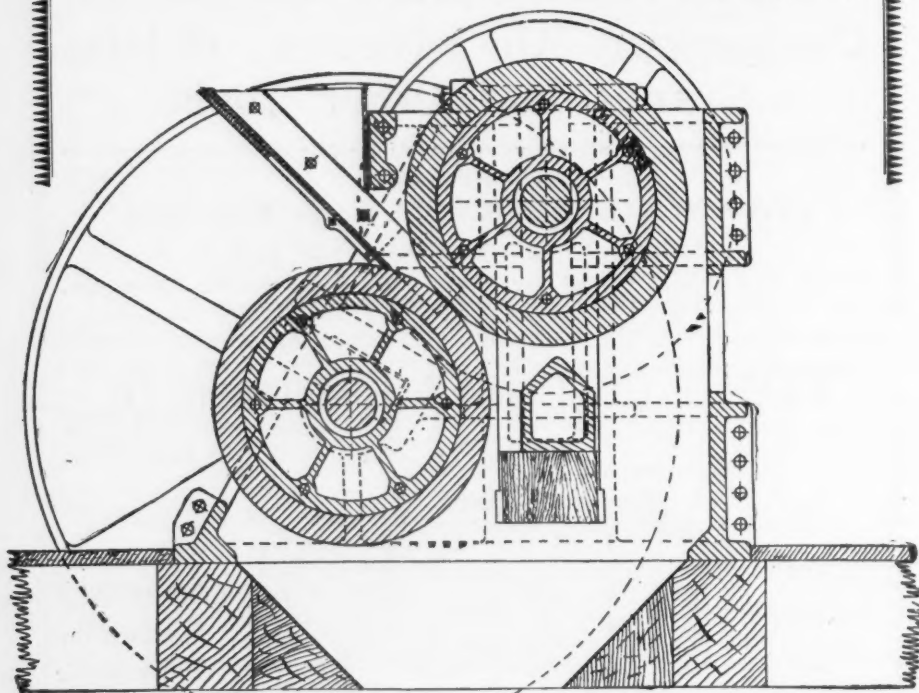
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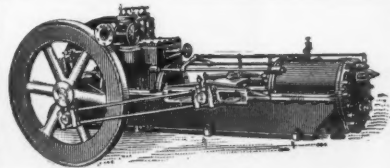
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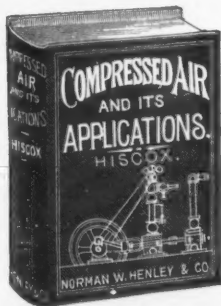
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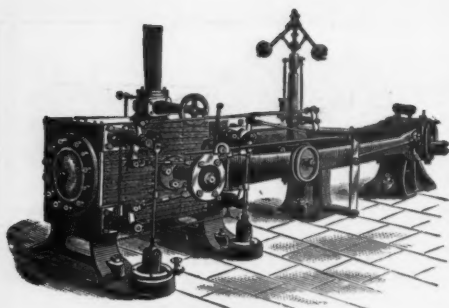
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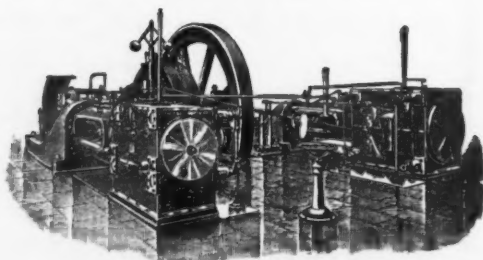
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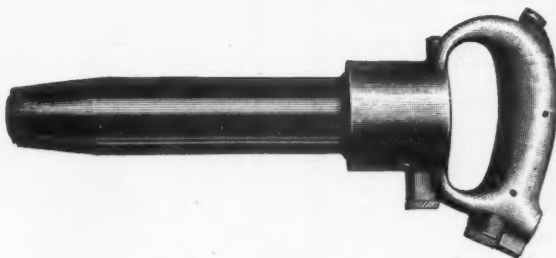
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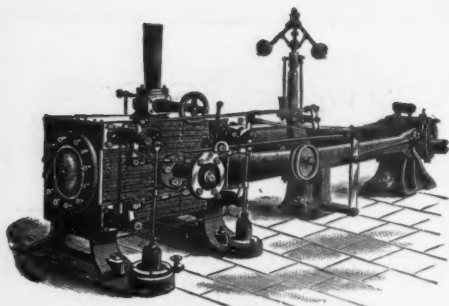
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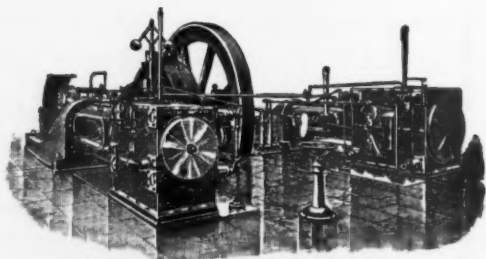
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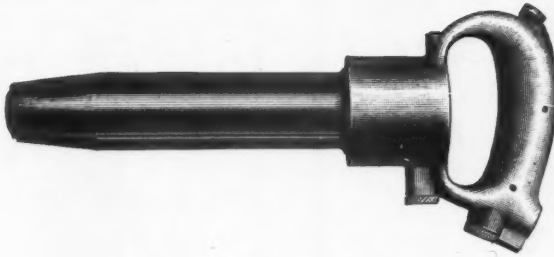
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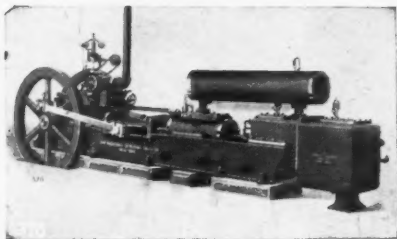
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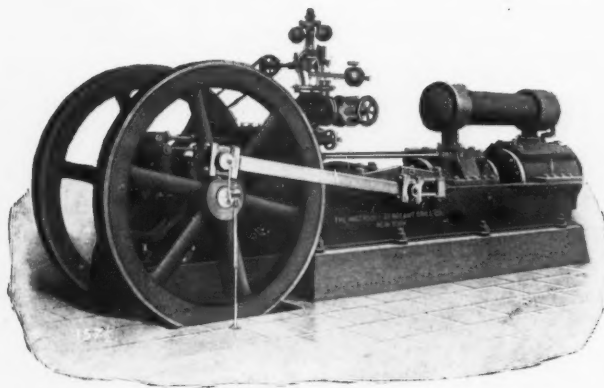
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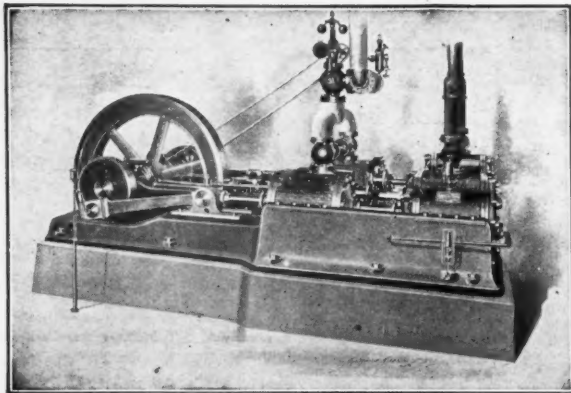


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